REGIONAL ARCHITECTURE:
A SUSTAINABLE ARCHETYPE FOR KAHOʻOLAWE

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May 2009

Submitted towards the fulfillment of the requirements for the Doctor of Architecture Degree.

School of Architecture
University of Hawaiʻi

Doctorate Project Committee
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We Certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in fulfillment as a Doctorate Project for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.

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"For every house is built by someone, but the builder of all things is God [Christ Jesus]*."*
(Hebrews 3:4 NASB)

The truth of this verse is revealed to us repeatedly in the numerous facets of life such as this project. This project is by no means the accomplishment of one individual, but the combined wisdom and support of my committee, family, friends, and the various individuals who have done research that made this project possible. Above all, this project was humbly accomplished through the strength, power, mercy, grace, and infinite love of Christ Jesus. To God be the glory.

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INTRODUCTION

This project aims to demonstrate that Regionalism integrated with a focus on Sustainability and Culture creates place specific, sustainable, and culturally appropriate architecture.

Regionalism and sustainable design methods are essential to creating appropriate meaningful architecture of place that people can identify with. All the contextual forces of a region such as, climate, resources, culture, economics, historical context, and technology, inform design. Cultural values are sources of inspiration for creativity to approach design. Cultural values are represented through architecture

Regionalism is a well suited design method that when coupled with strategies of sustainability and cultural integration can provide a holistic approach to architecture. Regionalism's framework assists the architect in addressing all the contexts for a project specific to place especially aspects of sustainability and integrating cultural values.

Kahoʻolawe Island represents the Hawaiian cultural heritage and revival. The restoration effort on Kahoʻolawe could be appropriately communicated through a regionalist design approach to help Hawaiians, Restoration Staff, and Volunteers better understand the value of the Island past, present, and future.

The following research defines Regionalism, Sustainability, and Culture to develop a hybrid regional design methodology. Three specific case studies analyzed and evaluated the design process of architecture with a respective focus on Regionalism, Sustainability, and culturally sensitive design. This research uses these definitions and examples to develop a hybrid design method termed Culturally Sustainable Regionalism. The ability of this hybrid design methodology to create place specific, sustainable, and culturally appropriate architecture is demonstrated in an application located on Kahoʻolawe.

PART I

DISCUSSION

CHAPTER 1

DEFINING REGIONAL ARCHITECTURE

> *"For successive regions, there are often common circumstances; but it is those circumstances which are unique to a region that give rise to a particular architectural identity for each region."*
>
> (Adrian Welke, 1978)

Shifts over time in culture affect the meaning of things and the definition of Regional Architecture is certainly no exception. There are distinct differences between the past definition of Regionalism and the term that has developed recently known as Critical Regionalism. Distinctions in architecture develop slowly over time creating recognizable evolutions of design aesthetic and structure known as architectural styles. This continual morphing of architectural styles becomes an important indicator of changing trends between different scales locally and globally, in human history.

Regionalism like most architectural styles is a relatively recent term compared to the length of recorded history. Before the 19th century, architects were not defined by architectural styles because the profession was simply not politicized as such; it was not until the 20th century that the identification of numerous categories became commonplace and the choice of style ideological.[1] Architecture is always in transition. As an architect, being identified with a specific style is inevitable. An effort to resist categorization and

[1] Jeremy Melvin, *Isms: Understanding Architectural Styles* (New York: Universe Publishing, 2006), 6.

do something different is the mechanism that creates architectural styles. Inventive designers who look to improve and answer architectural problems begin to create new architectural styles that others can follow in example.

The architectural style termed Regionalism is the product of a divergence from the placeless styles of Modernism and the continuously changing style of the Vernacular. This divergence from Modernism and Vernacular styles led to the distinction known as Regionalism. This research aims to argue that Regionalism can be better with a stronger focus on sustainability and cultural contexts. Regionalism develops its foundation from Vernacular architecture.

Vernacular architecture utilizes traditional technologies using available resources to meet specific needs, accommodating the values, economies, and ways of living of the cultures that produce them.[2] Vernacular architecture is strongly related to the environmental context and to the culture inhabiting a particular region. All forms of Vernacular architecture are products of the skills, knowledge, and resources available to the community.

The major difference Vernacular architecture has in comparison to all other styles of architecture is its association with time. Vernacular architecture may develop or adapt as needed by the local culture and environment without adherence to time.[3] The style's primary purpose is to satisfy the basic needs of a people. Vernacular traditions are threatened by globalization and often viewed as roadblocks to progress instead of an architecture that is well adapted to local cultures, economies and environments.[4] The Vernacular style's ability to remain consistently defined and present through time

[2] Marcel Vellinga, Paul Oliver and Alexander Bridge, *Altlas of Vernacular Architecture of The World* (New York, New York: Routledge, 2007), xiii.
[3] Ibid.

[4] Ibid.

contributes to this negative view. The need to satisfy the architectural demands of progress and development may have paved the way for regionalism.

Regionalism is design that goes beyond traditional building forms and aesthetics to explore the creative inspiration that can be derived from cultural values. "Regionalism attempts to put back into architecture what orthodox Modernism conspicuously took out, namely, continuity in a given place between past and present forms of building."[5] Regionalism kept a strong connection with the visual element of Vernacular architecture. Although the two styles would visually appear polar opposites, mostly due to construction and material quality, there is a conscious effort in Regionalism to convey similar aesthetic qualities of Vernacular architecture in shape and form. For example, Regionalism, in attempt to make an appropriate architecture, might mimic the building materials and forms of the indigenous architecture of the region. This creates false representations of the true vernacular and/or traditional architecture of a region because it does not respect the important aspect of time and is mimicking elements from a changed system of cultural values. This is discussed more in the Defining Culture chapter.

Regionalism is a product of Modernism and Vernacular architecture by nature of its characteristics. "Though by definition it varies according to location, what links Regionalism's manifestations . . .is the common commitment to designs that respond to local conditions, often drawing on indigenous traditions as well as Modernism."[6] Modernism was gaining popularity as the placeless architecture lacking meaning and identity. Although modernism was innovative its designs began to produce buildings that had no connection to the place they were being built. Modernism was bringing with it imposing values of culture empty of creative inspiration derived from the surrounding culture. On the other hand Vernacular architecture was being viewed as non-progressive

[5] Chris Abel, *Architecture & Identity: Responses to cultural and technological change*, 2nd Edition (Boston, Massachusetts: Archiectural Press, 2000), 163.
[6] Jeremy Melvin, *Isms: Understanding Architectural Styles* (New York: Universe Publishing, 2006), 124.

and unable to adapt to increasing globalization. In essence, Vernacular architecture does react to historical context it is a product of a particular influence of climate, place, and time. Vernacular architecture is a direct product of the materials and construction skills commonly available in a region. Modernism allowed for bold explorations in expression, technologies, materials, and forms while Vernacular architecture provided the foundation desired to give a building location, meaning, and identity.

Regionalism did bring with it a layer of inspiration beyond that of Vernacular architecture, and that is historical context. Regionalism implemented the use of drawing inspiration and justifications for designs from the historical context of a place. "An historical context is important for any discussion of a region's architectural character" as it provides continuity and identity.[7] Historical context captures the embedded sense-of-place in designs because it reflects a culture's actions and experiences from generation to generation.

Regionalism has had success but it is unable to fully address more recent urban building needs. In response, cultures have ended up hybridizing universal building types so that they can be adapted to local climate, site and social conditions.[8] Regionalism's strong association to aesthetics adopted from the Vernacular style has gained criticism as an in-authentic attempt at sense-of-place. The universal building types used in commercial and industrial avenues need more than visual appearance as justification for identity and place. Culture needed an architectural response that solved the short falls of Modernism and Regionalism.

During the recent years following World War II in the Hawaiian Islands an Architect named Vladimir Ossipoff recognized the dichotomy between Modernism and cultural values. Ossipoff saw the Hawaiian Islands, and more specifically Oahu, as an

[7] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 4.
[8] Chris Abel, *Architecture & Identity: Responses to cultural and technological change*, 2nd Edition (Boston, Massachusetts: Archiectural Press, 2000), 204.

"interchange between global modernization and the regional particularities" where "a unique pattern of design and construction" could be produced.[9] Architects like Vladimir Ossipoff could see the changes in architecture occurring and perhaps anticipated or seized the opportunity to develop a new design style. In response, to Regionalism's limits among various urban building types, emerged a new definition termed Critical Regionalism.

Critical Regionalism is not a style; it is an academic discussion and effort to rethink Regionalism. As stated by Alexander Tzonis, in his book *Critical Regionalism: Architecture and Identity in a Globalized World*, Critical Regionalism is an effort "to rethink Regionalism . . .as a bottom-up approach to design, that recognizes the value of the identity of a physical, social, and cultural situation, rather than mindlessly imposing narcissistic formulas from the top down."[10] Tzonis argues that Critical Regionalism is an exploration of identity of the particular. This means a design methodology that focuses on the specific contexts of a specific place and site. Imploring this concept in design helps to counter the top-down, placeless architecture of globalization and the international style.

Kenneth Frampton, noted architectural critic points out that, "Critical Regionalism is an approach to architecture that strives to counter the placelessness and lack of meaning in Modern Architecture by using contextual forces to give a sense-of-place and meaning."[11] This is a redefining of Regionalism that was placing an emphasis on the visual aspects of buildings shifting to a new emphasis on topography, climate, light, tectonic form and

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[9] Karla Britton, "Honolulu: Toward a Regionlist Urbanism," in *Hawaiian Modern: The Architecture of Vladimir Ossipoff*, ed. Dean Sakamoto, Karla Britton and Diana Murphy, 127-146 (Honolulu, Hawai'i: Honolulu Academy of Arts, 2007), 129.

[10] Liane Lefaivre and Alexander Tzonis, *Critical Regionalism: Architecture and Identity in a Globalized World* (New York, New York: Prestel, 2003), 11.

[11] Kenneth Frampton, "Towards a Critical Regionalism: Six Points for a Architecture of Resistance," in *The Anti-Aesthetic: Essays on Postmodern Culture*, ed. Hal Foster, 16-30 (Port Townsend, Washington: Bay Press, 1983), 2.

tactile sense. The discussion of Critical Regionalism helped to refocus the holistic concept of Regionalism back onto what is referred to as 'contextual forces'. The contextual forces are the specific qualities of a place that can be attributed to its identity. Contextual forces are specific to each region and include aspects such as environment, history, culture, existing buildings, resources, politics, and economics. Design inspired by the contextual forces of a region helps to communicate a sense of place and meaning free from the economically costly, ecologically destructive, and culture depriving qualities of globalism.

Critical Regionalism provides the most comprehensive approach to incorporating sustainable design strategies. Sustainability has much larger implications than just energy efficiency and recycling. Sustainability in the fullest sense is an examination of every aspect of a building, which includes the site and surrounding region, to implement self-perpetuating environmentally responsible structures. Sustainable design is not as sustainable as it could be with a more holistic approach to design. A regionalist design method with an increased focus on sustainability could produce a more applicable and appropriate architecture in various regions worldwide.

1.1 SEARCH FOR IDENTITY

Regionalism has been consistently sought to provide a solution to the problem of identity by taking a holistic approach to design that addresses the contextual forces existent at a specific place. Localizing architecture is a key strategy to counteracting the paintbrush of globalization and restoring people's, culture's, and nation's identities. The meaning and identity of a people is expressed through architecture inspired by their cultural values.

Globalization has also proven to be destructive to cultural identity by creating placeless buildings. Globalization does not have the ability to satisfy one of the basic needs of a

culture, which is identity. A loss of the sense-of-place and a breakdown in identity has encouraged architects and cultures to seek other solutions. Regionalism is becoming more important as a design method to maintain cultural identity through architecture. Without a design methodology that makes an effort to locate architecture to its region, globalization will continue to produce placeless buildings.

Placelessness describes the missing connection between a building and its context. The context encompasses every aspect of a site expanding outward from environment, resources and local culture to political, economical, and technological influences. "When there is a common set of circumstances, it follows that the buildings deriving from these circumstances will in essence be similar. In this way an architectural region may be identified."[12]

A place has recognizable boundaries separating one space from another. These boundaries can be real or imagined and act to distinguish a place by position, importance, or identity.[13] The boundaries of a place can be a number of things from mountains, oceans, and rivers to invisible state lines, nations, and countries. Variations in architecture reinforce the identity of a particular place or region. Defining place is crucial to locating architecture.

The scale of a region and its defined boundaries has significant implications on design. The contextual elements of a site located on a continent are going to have different impacts on the design then a site located on an island. An island location, for example, has very different resources, most resources are imported and those that the island can provide have to be used much more responsibly. A continental region on the other hand has more access to a variety of resources locally, which affects the architecture and

[12] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 2.
[13] George S. Kanahele, *Ku Kanaka, Stand Tall: A Search for Hawaiian Values* (Honolulu, Hawaii: University of Hawai'i Press, 1986), 176-178.

values of the endemic culture. Islands have vastly different climatic concerns such as wind, rain, and ocean forces that influence architecture. There are also very different boundary determinations, notably the ocean and topography of the land. The mere scale of island regions changes the value of land and the approach to building on it. Environmental integration is much more critical in an island setting than in a continental region. Climate, resources, topography, government, and culture among other things change from region to region each impacting architecture differently. Regionalism is a good holistic method for locating architecture.

1.2 ECOLOGICAL TIES

Sustainability and the development of environmentally responsible architecture is an inherent quality of the Regional style. As sustainable design gains momentum in the 21st century it will likely attach itself to or be a branch of the Regionalist movement. Regionalism is the perfect match for a sustainable approach to design. The "next generation of architects has moved beyond the attractive" characteristics "of regional architecture, to a re-thinking of the fundamental issues of space, material, practice, tropicality, sustainability, urbanity, and place."[14]

It is already being seen by a number of architects and sustainable assessment systems that true sustainability relies on more than energy efficiency. An appropriate response to climate requires a suitable technology and sustainable design strategies. Advocates of sustainability agree that technology plays a significant role in the development of sustainable practices but the method of implementation and political agendas are problematic.[15] Sustainable design needs to be matched with an appropriate architectural

[14] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 17.
[15] Chris Abel, *Architecture & Identity: Responses to cultural and technological change*, 2nd Edition (Boston, Massachusetts: Archiectural Press, 2000), 206.

design methodology that broadens the design focus to include more qualities of the regional context.

Eco-development requires both appropriate technological and built solutions to produce environmental results while Regional architecture requires ecologically sensitive building policies and appropriate technologies to create a normative building pattern.[16] In other words, the sustainable design movement needs constructed appealing examples to gain momentum in the culture as an understood and acceptable style. Regional architecture needs to integrate more noticeably sustainable features to attract a consistent demand for building. This means that Sustainability and Regionalism are the perfect match because they rely on the other qualities to succeed. If Regionalism were a product of the search for identity in globalized architecture then Sustainable Regionalism would be the search for justification. The ability of a culture to self-sustain justifies its qualities and identity.

1.3 FRAMEWORK – EIGHT CONTEXTUAL FORCES

Every region has specific contextual forces. The contextual forces of a region, which includes all the aspects of culture, are the primary means by which inspiration and justification for a design can be found. The following contextual forces are aspects of Regionalism that help define the variables taken into consideration for designs. The contextual forces have been generalized and put into broader categories such as "environment" to describe more specific forces like topography, water, climate, vegetation, and soils. It should also be understood that these broader categories do not necessarily account for all the contextual forces likely to be present at a given site. For example, language could potentially be another major contextual force.

[16] Chris Abel, *Architecture & Identity: Responses to cultural and technological change*, 2nd Edition (Boston, Massachusetts: Archiectural Press, 2000), 207-208.

There are eight major contextual forces that should be addressed in a Regional design approach: Environment, Architecture, History, Culture, Resources, Technology, Politics, and Economics. The importance of each contextual force is part of what gets determined through research in the design process. For example, the historical context for a region and specifically a site may have little to no significance in shaping architecture sympathetic to that place. There simply may not be historically significant aspects at the site. It is important nevertheless to address the following contextual forces whether significantly present or not to ensure a sound thoughtful design.

ENVIRONMENT

The contextual force of Environment can be broken down into several subsets of which five are significant aspects: "Topography, Water, Climate, Vegetation, Soils."[17] Each of these subsets are typical aspects researched in western architectural practice in a site survey. These subsets apply to any region island or continental. "Until technology made it possible to artificially modify the climate within a building, architecture could scarcely escape a close connection to its surroundings."[18] Now, everything from the topography of the site to the water features and vegetation are artificial detachments from the surrounding environment.

Japan's Ocean Dome in Miyazaki is an example of just how much man can remove himself from the surrounding environment. The Ocean Dome is a completely artificial environment, it could be sited in Antarctica and people would still be able to enjoy the warm sunny beach. The Ocean Dome is even located right near a real beach but people prefer the controlled predictability of the artificial environment. Technology has unfortunately separated humanity from the natural environment of a region and trapped them indoors breaking the connection to place. The environmental context is perhaps the

[17] Marcel Vellinga, Paul Oliver and Alexander Bridge, *Altlas of Vernacular Architecture of The World,* (New York, New York: Routledge, 2007), 3-17.
[18] Jeremy Melvin, *Isms: Understanding Architectural Styles* (New York: Universe Publishing, 2006), 7.

most important contextual force in defining a region and the resultant architecture.[19] A separation from environment, no matter the level of comfort it provides, is a separation from place that results in an un-natural and confusing relationship to place.

ARCHITECTURE

Existing architecture is a contextual force that can reveal the most about a region. People reveal their values through their buildings and built forms. Architecture reveals something about the builder's cultural values because built structures overtly express cultural values.[20] "Alive-and-well regional forms of buildings have the potential of providing examples of different spatial and sensory experiences, methods of building and construction, and means of adapting to various environmental and sociological impositions."[21] Architecture is a window to each regions characteristics and influences. The existing architecture, if there is any, is the best record of the contextual forces of a region. This especially demonstrates climatic conditions and the life styles lived by the residing people group. Existing architecture makes up part of the historical record of a place.

HISTORY

The historical context is a record of time and events that have occurred in a region. Specific sites may have unique histories that should be addressed in the architecture representing that place. Even negative memories of a tragic event are important to people and should be addressed in a design appropriate to place. Historical context is an important part of a regions' identity.

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[19] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 26-29.
[20] Dora P. Crouch and June G. Johnso, *Traditions in Architecture: Africa, America, Asia, and Oceania* (Oxford, New York: Oxford University Press, 2001), 285.
[21] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 138.

The evaluation of the historical context for a region provides a great indicator of the values held within that region. History can do more than mark a change in time it can show the similarities. Although history often focuses on changes it can also demonstrate the continuity of a culture.

CULTURE

The beliefs, religion, social customs, and art of a culture contribute greatly to the interpretation of space and form in a region. The proper understanding of culture creates "an attitude which can be applied without the baggage of semiotics or obeisance to a picturesque vernacular."[22] In other words cultural context can inspire and justify an emphasis other than visual similarity between more traditional and vernacular forms. People may identify entirely with the land in which they live such as the Hawaiians or Anangu people of central Australia. The Hawaiian identifies strongly with the land in which he lives. The land is his living, past, and life force. Understanding this relationship can be expressed through architecture in many more ways than the mimicking of traditional forms, materials, and buildings styles.

A deeper understanding of culture, particularly the indigenous culture, frees architecture to represent the values of a people in modern three-dimensional space. Architecture is not limited to traditional materials and forms in order to incorporate culture. The culture of a people is constantly evolving and progressing through time just as everything else is, which means culture is free to and should be represented through modern architecture. Modern technology and innovative materials can represent indigenous cultures values just as they were represented through the technology and materials of years before. Taking the time to understand the cultural values of a people is the challenge to creating an appropriate architecture that represents them. This topic is discussed more comprehensively in the Defining Culture chapter.

[22] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 19.

RESOURCES

As Philip Goad and Anoma Peiris discuss, "each place is different and this means that architecture can be, and often is, different across the region. Any major difference is due primarily to local material and construction practices."[23] The resources available to a region overtly affect architecture. Domestic resources are the ideological source for materials but that certainly does not limit the use of foreign resources. An island region for example is typically dependent on imported materials and resources. Regionalism recognizes the progressive value in utilizing imported materials in response to the contextual forces of a region. Resources are easily identified with place and as such bear a substantial amount of the identifiable aspect in architecture. Resources carry with them meaning and an association to either the environment or a peoples relationship to the environment. The effective use of resources is greatly impacted by the technology enlisted with its use.

TECHNOLOGY

Technology is the continually developing method for accomplishing goals better, faster, and more efficiently. Technology should not be viewed as a harmful thing but something that can better architecture and the built world. Technology can simply mean a more efficient communication process between architect and client or it can mean a building producing more energy or resources than it uses. Technology can be a wonderful catalyst to appropriate responsible architecture. For example, the Hawaii Gateway Energy Center located on the Big Island of Hawaii embraced technology and it resulted in a regionally appropriate design that respects the environment. The Hawaii Gateway Energy Center appropriately and responsibly used technology to take advantage of the natural energy resources of the region. Technology is often politically connected because of its value to culture.

[23] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 14.

POLITICS

A region's political character can either promote or hamper the implementation of various contextual forces namely technology.[24] Politics is the process by which groups of people make decisions. Sometimes these decisions are tied with the personal desires of the individuals that are involved in the decision making process. Political agendas have a tendency to supersede many contextual forces for personal goals. The political fabric of a region is an allusive but dominant force to the physical makeup of cities and countries. Identifying the influences of a political context is beneficial to the outcome of a project. For example, the Hawaii Gateway Energy Center was able to secure project funding because of its potential to stand as a model of the State of Hawaii's sustainable independent future. Several decades prior to the sustainable moment developing today, the notion of a zero-net energy building would have been seen unnecessary and a waste of time. Now with federal funding and a national switch to more sustainable practices the political fabric is avidly supporting sustainable projects.

Technology is usually the scapegoat in political agendas because it carries the most influential financial prospects or consequences. Technology is most often looked at as power and wealth. Because of this politicians and leaders use the control of technology to satisfy their agendas. The hope is that the political agenda is for the betterment of the people but regardless politics has an impact on design. Technology and politics are centered heavily around financial matters. In addition, the economic context of a region is largely the result of political actions.

ECONOMICS

The economical context of a region can greatly affect the architecture adopted by a culture. There are three economic systems seen throughout the world, they are

[24] Chris Abel, *Architecture & Identity: Responses to cultural and technological change*, 2nd Edition (Boston, Massachusetts: Archiectural Press, 2000), 206.

subsistence, trade, and market economies.[25] A subsistence economy is supported solely by a group and relies on natural resources to survive. Similarly, the dwellings of a subsistence economy are derived directly from natural resources with little refining. Trade economies have the ability to produce quantities above the needs of a people resulting in trade markets. This exposes a region to outside cultures and their subsequent technologies, materials, and styles. Market economies have an ultimate objective of financial gain.

As a market economy develops it begins to loose its connection to place because the people no longer recognize their material resource. Architecturally, this creates urban environments that begin to loose connection with the region. Instead of working the land to provide food and shelter for living, a majority of a nation's citizens live through other means disassociated with the land they live on. The economics of a region influences architecture. Understanding the economic context can inform design to create an appropriate acceptable architecture.

All of the contextual forces of a region can inform design to create appropriate place specific architecture. The regionalist design method is arguably the most holistic method for addressing the large variety of design problems that architecture faces. Regionalism has a unique quality that makes it extremely useful and arguably superior to other design methods.

1.4 SPECIFIC USES

The regionalist design approach is useful for many design problems but there are some applications where Regionalism specifically provides an appropriate design solution

[25] Marcel Vellinga, Paul Oliver and Alexander Bridge, *Altlas of Vernacular Architecture of The World* (New York, New York: Routledge, 2007), 12.

beyond other styles. Regionalism is specifically appropriate in addressing cultural issues, placeless architecture, and issues of sustainability. Regionalism helps restore cultural identity by representing cultures values through an architecture that can be identified with place.

People, typically in Third World countries, find the effects of Modernism and Globalization threaten their way of life. The "decision of what does or does not belong in their region acquires political and emotional dimensions" that results in "a struggle for cultural survival, recognized as a 'search for identity'."[26] Today Globalization is one of the more obvious forces pressuring cultures to conform to a universal style. During the 19th Century regions, like Hawa'i and New Zealand, were feeling the threat posed by colonization and the devastation it brought to the indigenous cultures. Colonization nearly wiped out the indigenous cultures of Hawa'i and New Zealand. Maoris, the indigenous culture of New Zealand, are recovering from colonization and the use of modern materials, technology, and architectural designs are a strong component to their recovery. Indigenous Hawaiian culture is not as far along as the Maoris but perhaps Kaho'olawe could be the foundation to a stronger recovery process.

"The regionalist debate had its greatest audience in Southeast Asia, where rapid Globalization posed a threat to national cultures derived from the rural vernacular."[27] Globalization is separating the people from their association to the land. As Globalization brought with it universal architectural styles the identity previously found in the region was being replaced, impacting cultural values.

[26] Chris Abel, *Architecture & Identity: Responses to cultural and technological change*, 2nd Edition (Boston, Massachusetts: Archiectural Press, 2000), 163.
[27] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 30.

Regionalism is sympathetic to cultural identity and the contextual forces of a region. Regional architecture is accepted and useful in culturally sensitive situations because it is a representation of the cultural values. People can identify with architecture that expresses their values. Architecture that imposes the values of a culture that is not indigenous to the region it is being located detracts from the local communities sense of identity. Regional architecture can help reinforce indigenous cultural identity.

The universal building style riding on the coat tales of Globalization is responsible more than any other thing for the placeless architecture around the world. Regionalism is beginning to be the primary solution to re-establishing place in architecture. In an increasing complex world where cultures are interacting on a massive scale, cultural identity is blurred and often hard to define. Regionalism may be an approach to understanding the boundaries of a region and the cultural identity of the people within that boundary. Regionalism provides that system and approach helping architects focus on the contexts that make up a region. This produces more appropriate design that reflects the place in which it is built. Appropriate design reflecting the qualities of place is unavoidably sustainable.

Regionalism has the necessary characteristics that make it perfect as a catalyst for sustainability. The only real differences between Regionalism and Sustainability are culture and energy. Sustainability on the other hand places a heavy emphasis on energy efficiency but draws no inspiration from cultural contexts. It would be logical then to merge the two styles/movements to improve the effectiveness.

In Conclusion, a civilization's architecture is almost a complete record of its history. Every structure captures in three-dimension the climate and resources of a landscape, social, economic, technological and political conditions of a culture with their moral, philosophical, and religious beliefs. In this way it is not surprising that a Regional

approach to architecture appeals globally at a local scale. Regionalism gives "identity" to modern architecture.

Regionalism is a design style that draws inspiration from the contexts of a region and reflects them in architecture. The holistic design method of Regionalism is the best tool for counteracting the placeless architecture of Globalization. The contextual forces of a region are the primary sources of inspiration and identity that architecture needs to reflect. A regionalist approach to design allows architecture to embody and represent the values of people within a region.

1.5 CASE STUDY – REGIONALISM

The following case study is an example of the process and product of regionally focused design. The study also shows the overlap between Regionalism, Sustainability, and cultural integration into building designs.

Key Parameters

Project Name:	The Green Can
Location:	Karama, Darwin: Northern Australia
Architect(s) / Firm:	Adrian Welke & Phil Harris / Troppo Architects
Date of Completion:	September, 1981
Gross Square Footage:	Approximately 1,000 Square Feet
Cost:	$34,000 (Government houses at the time usually cost $45,000 to $48,000)
Program:	Living space, Three Bedrooms, Bathroom, Laundry, Kitchen
Construction:	Lightweight exposed steel frame, corrugated iron cladding, timber lattice infill's
Building Type(s):	Residential, Single-Family
Design Approach:	Investigation of Regional Contexts

ABSTRACT

In the year 1981, as part of a Low Cost House Competition, a newly established architecture firm called Troppo entered a design nicknamed 'The Green Can' after the signature green Victoria Bitter beer. Eleven winning projects were built in the suburb Karama of Darwin, Australia and the Green Can was one of them. The Green Can was built at a cost of less than $34,000 challenging all contemporary house designs at the time

in Northern Australia. The design was practical and employed a whole-of-site approach along with several guiding principles developed by Troppo Architects.

In 1981, Phil Harris and Adrian Welke established the firm Troppo Architects in Darwin, Australia.[1] This residential prototype was pivotal in the foundation and physical manifestation of Troppo's design philosophy and cultural influences. Troppo's design philosophy is an exemplary display of regional design theories implemented with care and knowledge of the contextual forces of a region. The design provides a conscious interaction with the surrounding environment. Aesthetic, material, and functional qualities draw from cultural aspects of the region.

Its steep opposing skillion roofs and prominent circulation corridor identify the Green Can. This circulation corridor optimizes space effectiveness by also integrating natural ventilation. The opposing skillion roofs were designed for optimal wind loading and help the exhausting of hot air from the interior spaces to maximize the passive convection process.

The most important idea the Green Can proposed was that of accepting the environment existing at a particular site. Non-indigenous people viewed the Top-End of Australia as harsh and mostly uninhabitable. The environment was not being approached as something to interact with but rather separate from and because of this people were not identifying, at least positively, with the region. The Green Can was proposing that the environment should be interacted with and doing that meant accepting a different perception of comfort. As a result the Green Can created an avenue for discussion and exposed people to Troppo's new regionalist design philosophy.

[1] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 21.

Figure 1.1 Green Can, 1981[2]

BUILDING

The Green Can is a single-family home of approximately 1,000 square feet. There is one main level constructed on a post and beam floor system with a central circulation corridor. There are three entrances to the house, one at each end of the central circulation corridor and one at the center of the house that opens into the living space. The space is broken into two parts separated by the circulation corridor. On one side of the circulation corridor there are three bedrooms and a living space, blurring the line between inside and outside, organized on a grid. On the other side of the circulation corridor are the service spaces consisting of a bathroom, laundry, and kitchen. Most of the walls perpendicular to the central circulation corridor are adjustable timber lattice infills. The structure is made of lightweight steel with corrugated iron cladding. The ceiling is exposed corrugated iron.

[2] Patrick Bingham-Hall, "Green Can 1981" (image), *Troppo Architects* (Singapore: Periplus, 2005), 26.

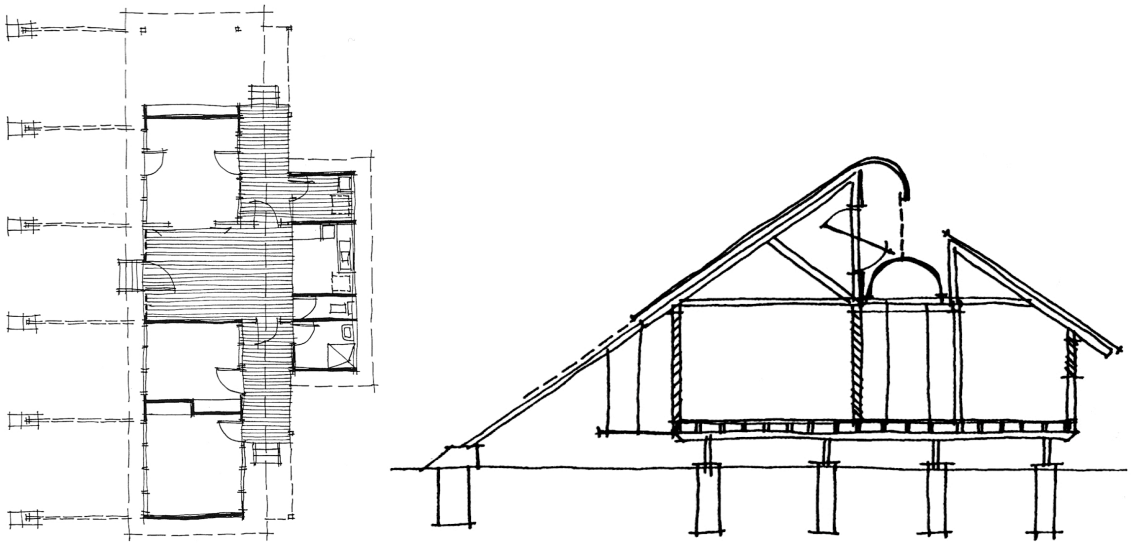

Figure 1.2 Green Can Plan & Section[3]

The Green Can is a model of design principles that Harris and Welke developed through two different studies of the Top End region of Australia. Harris and Welke ultimately developed ten design principles currently known as the 'ten thematic constants' that will latter be discussed in further detail. Based on these design principles the Green Can is "oriented to catch the wet season breezes from the north west, and the dry season breezes from the south-east, the house is distinguished by its steep opposing skillion roofs (35 degrees optimum design pitch for wind loading)."[4] The Green Can is open, adaptable, and designed around a ventilating breezeway and a roofed outdoor room in the center of the house. The center living space is designed to allow cross-ventilation into the center of the house and create a space that connects people to the environment. This is done by orienting the building perpendicular to the dominant wind direction, which allows air to pass through the building using louvered walls and windows.

[3] Patrick Bingham-Hall, "Green Can Plan & Section," (image), *Troppo Architects* (Singapore: Periplus, 2005), 26.
[4] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 26.

The Green Can was confronted with criticism and interest. Six variations of the Green Can were built in total, five by Troppo and one stolen design.[5] The house commissions that came out of the Green Can prototype helped to promote and familiarize people with the lifestyle that came with Troppo's ten design principles.

Troppo architects set the tone for their design style by demonstrating their regional principles with the Green Can. This was the firm's first project that allowed architects Phil Harris and Adrian Welke to physically present their design principles. The goal of this case study is to examine the process, translation, and implementation of a regional design method. The study looks at what aspects of the region were researched in preparation for the design. Understanding what the architects explored in the region is critical to realizing the purpose and reasons for various elements of the design.

Translation of the research to design principles and then translating the design principles into a physical design is the main emphasis of this case study. Troppo uses ten thematic constants that help guide their designs. These principles are a result of years of research on the Northern Territory of Australia and more specific micro regions such as Kimberley, Darwin, and Queensland.

PROJECT PERSPECTIVES

The architects took into account all the contextual forces of the region and thoroughly studied it building their practice around design principles derived from their study. For this reason the Green Can is a monumental project both for Troppo architects and the design method of Regionalism in architecture.

[5] Adrian Welke and Phil Harris, interview by Justin Clark, "Design Gone Troppo," *Houses*, (2002).

There are three things to examine about the Green Can, which are: the study and research that lays the foundation for the project; the ten thematic constants or design principles that resulted from the study of the Northern region of Australia; and the physical manifestation of the research and design principles in a building. Each of these perspectives reveals insightful knowledge of Regionalism. Regionalism that goes beyond the superficial layers of aesthetics and materiality to the deep meaning of spatial relationships and environmental response creates true identity.

The founding of Troppo Architects and the construction of the Green Can are really parallel events. Both can be traced back to a study presented in 1978 by four architecture students for their senior year, Phil Harris, James Hayter, Justin Hill, and Adrian Welke, of the University of Adelaide in southern Australia. In 1977 the students humorously nicknamed themselves 'acme anywhere,' which is an anonymous acronym commonly understood to mean 'a company that makes everything' and set off around the Australia coast. The study took the four students around Australia in search of architectural identity through an association with region. Aspects such as social, economic, and technological conditions formed part of their research. The research was presented in a 156 page joint report entitled "Influences in Regional Architecture" and publicized with a three-projector slide show identifying regionally appropriate architecture all over Australia.[6]

This study would latter get revisited by two of the original four students, architects Phil Harris and Adrian Welke. It is apparent that the design principles and philosophy formed by Troppo Architects are heavily influenced by the regional qualities found in Kimberley, Darwin, and Queensland. Kimberley was one of the first regions along the student's journey that reflected a strong influence of the environment context in the local architecture.

[6] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 11.

The Adelaide students recognized architectural consistency in construction and design methods influenced by the climatic context of Kimberley. Kimberley is a region of Western Australia influenced by gold mining settlements, Japanese and British pearlers, and cattlemen from eastern states. Each culture brought its own influences to the architecture with louvers from the pearlers and verandahs from the cattlemen. The designs that provided the most comfort relative to the climate endured in the region. The climate in Kimberley is best described as subtropical with two basic seasons, the Wet Season and the Dry Season. The wet season ranges from December to March and is characterized by high humidity, daily thunderstorms, and heavy monsoonal rainfall with possible tropical cyclones. The average temperature for the season is 85°F (30°C). The dry season ranges from April to November with low rainfall, clear skies, and occasional inland dust storms. The average temperature for the season is 100°F (40°C). The Adelaide students identified four climatic contexts the architecture in Kimberley responded to, which are:

1.) High daily temperatures – up to 100°F (40°C) and often high night temperatures.
2.) Heavy rainfall.
3.) High Humidity.
4.) Cyclonic winds – infrequently.

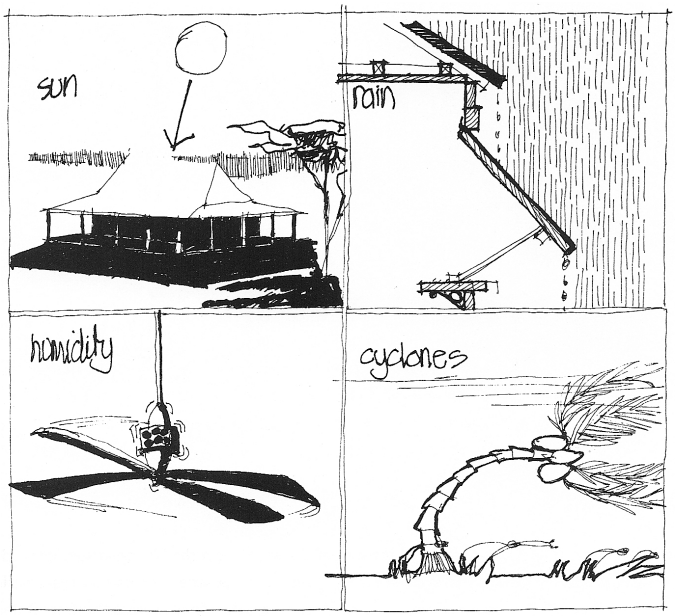

Figure 1.3 Climatic Elements of the Region of Kimberley[7]

[7] Adrian Welke, "Climatic Elements of the Region of Kimberley" (image), *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 68.

These four climatic elements have an astounding effect on the architecture developed in the region of Kimberley. The Adelaide students recognized several architectural features prominently implemented to respond to the climate of the region. Open planning, verandahs, awnings and shutters, louvers, lattices, and the use of flat sheet metal typified the architectural aesthetic of the region.[8]

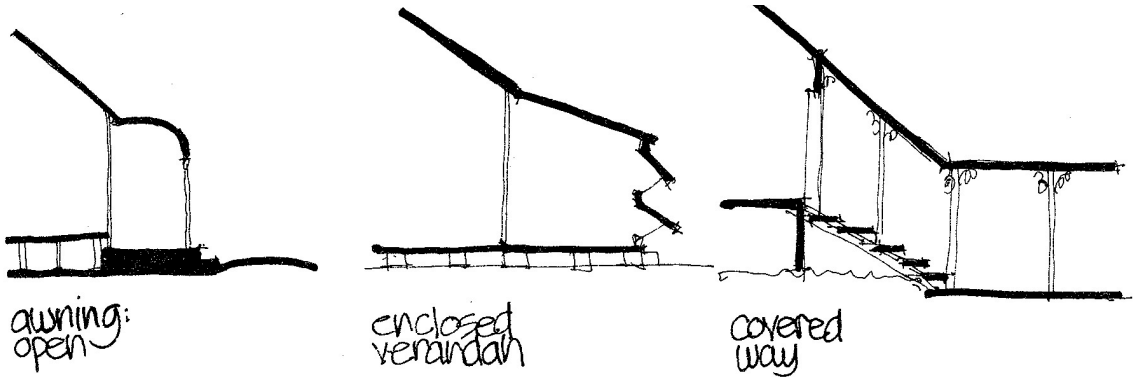

Figure 1.2 Verandah Types[9]

Open planning allows interior rooms to be isolated from direct contact with the outside climate. This also maximizes ventilation through all of the interior spaces. Verandahs create a buffer space between exterior climate and interior climate. Several different variations of the verandah were identified in the architecture such as open awnings, enclosed verandah, or a covered entryway. Attached to the verandah were a variety of elements used to protect from direct sunlight, rain, or wind. These consisted of shutters, louvers, or lattices based on the desired need for a space and were arranged in two levels from floor to ceiling to provide environmental control. Shutters provide shading as well as protection from rain and wind, which allows a building to close up during bad weather conditions. Lovers allow a window or wall to act as an adjustable ventilation surface. Lattices can help create a level of enclosure while providing adequate ventilation. Finally, flat sheet metals were extensively used for both the exterior roofing and siding. Besides the easy transportation of the materials, sheet metal cools rapidly shedding heat

[8] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 65-68.
[9] Adrian Welke, "Verandah Types" (image), *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 75.

once the sun goes down. An interesting observation made by the students was that most of the buildings lacked any sort of interior lining and relied only on the exterior sheet metal for interior finishes.[10]

Darwin in contrast to Kimberley was found to have a different influence on architecture other than the climate. Located Northeast of Kimberley, Darwin is an example of how the historical context of a place can be a prominent influence on the architecture and identity of a region. Although Darwin has the same climatic elements that Kimberley does, there is a change in the architecture that reflects a significant difference between the contexts influencing architecture in each place. Darwin's historical context appeared to be the major influence on architecture in the area. Darwin acts as a port to the whole northern region of Australia that includes Kimberley. Several major historical events have shaped its architecture over the last century. In the 1880's nearly one thousand Chinese had settled in Darwin. This limited development until after World War Two (WWII) when roads and communications that were built for the war increased the population.[11]

In 1973 Cyclone Tracy leveled the city. Following the cyclone, stilted houses with asbestos were being constructed based on their success in living with a similar climate in Queensland. The buildings were being constructed with extensive louvers and raised to promote breezes through the interior spaces. "It seems that with the aid of ceiling fans, this form of house when orientated correctly, provides sufficient relief from the climate, without the need for expensive and unhealthy air conditioning."[12] The Adelaide students recognized that ventilation was the key to more comfortable healthy buildings in the Top End environment. Ventilation was not the only influence in shaping the architectural aesthetic.

[10] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 70-79.
[11] Ibid., 97-98.
[12] Ibid., 99.

The local community made a significant impact on design. Residents suggested that in such a hot and humid climate creating a vastly different indoor climate, by use of air conditioning, could make contracting common colds and other sickness easier.[13] The cultures value of health over potentially less comfortable living conditions aided in promoting passively ventilated buildings. The local cultures identification with environment was being reflected in the architecture.

Not soon after re-building began, from the cyclone, a manufacturing industry was established in Darwin. The availability of newly and locally manufactured materials quickly produced an alternate architectural identity in the region. Heavy brick and concrete characterized the new construction most likely in reaction to the cyclone.[14] The devastation of the cyclone and availability of new building materials altered resident's values to focus on safeguarding against potential future cyclones and water surges.

These responses to economic change, a cyclone, and development shaped the architecture in Darwin different to the architecture in other northern towns and cities. The historical context described above is unique to Darwin, which showed evidence of different regional characteristics being reflected in architecture. Darwin best shows how various contexts of a place are reflected in the architecture but also the cultural values of the local community. Darwin underwent significant contextual changes that shaped the architecture of the region. Most notably the environmental change that resulted in a change in cultural values ultimately becoming reflected in the architecture.

Queensland, located in the Northeast area of Australia, revealed a final type of regional influence to the Adelaide students. The area of Queensland is populated more broadly

[13] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 99.
[14] Ibid., 97-100.

than other areas of the Top End with homes built in coastal and inland areas representing significant microclimate differences. Queensland portrayed a consistent use of timber and galvanized iron construction throughout the region despite obvious differences in both climate and local contexts. Invariably, it was realized that the tin and timber construction was appropriate and effective throughout the region regardless of contextual differences. The flexibility of the materials and architectural style gave it increased influence over other regional aspects.[15] Studying Queensland region revealed the dominating influence that a particular contextual force such as materials can have over the identity and sense of a place.

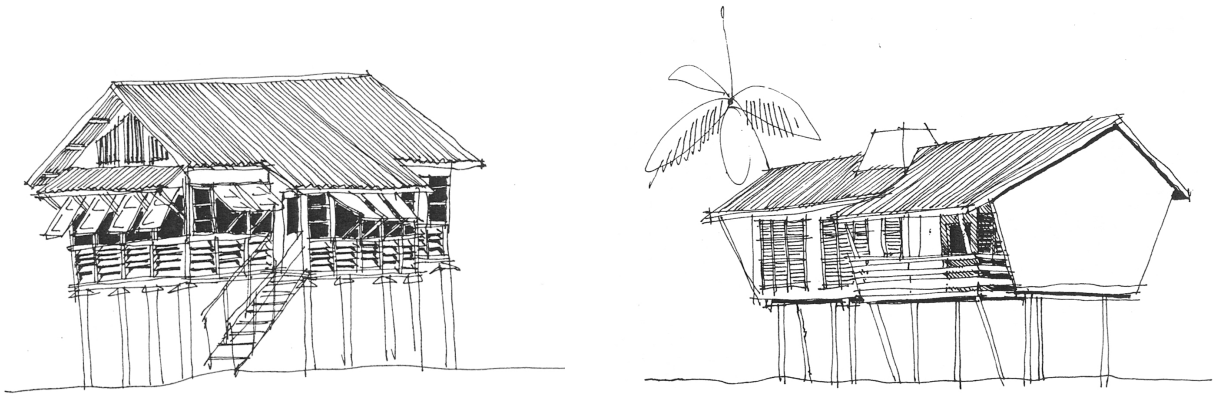

Figure 1.3 Stilted House[16]

The corrugated sheet metal available in the Northern region of Australia is an imported material. The sheet metal was not even originally from the locally available resources of the environment. Distance and the ease of transporting materials played a significant role in shaping the unique architecture of Queensland. The combination of timber and galvanized iron provided the simplest means of construction, which was a valuable component in the isolated areas of Queensland. The heavy influence of imported materials shaped the architectural aesthetic and much of the identity in the Northern region of Australia.

[15] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 105-112.
[16] Phil Harris and Adrian Welke, "Stilted House" (image), *Punkahs & Pith Helmets: Good Principles of Tropical House Design* (Darwin: Costless Printing, 1982), 13, 17.

Perhaps the biggest lesson learned from the study of Queensland, aside from particular building characteristics, is the impact of social values. The students discovered that timber and galvanized iron buildings were able to apply to such a large area with different climatic conditions because one, it worked well in numerous climates and two, differences in social status accepted the universal construction method. For example, a rich man and a poor man both used timber and galvanized iron for their home because of its virtues as an almost ideal material for use in Queensland.[17] Normally economically successful people within a group use stone or rare building materials as a status symbol but the culture of the Queensland region valued practicality more than wasteful symbols of status.

The four Adelaide students investigated many other cities and regions around Australia in their search for architectural identity through association with region. The students learned that regional architecture is affected and influenced by a number of forces but more importantly it is instrumental in providing valid sociological and environmental designs. Phil Harris and Adrian Welke took the knowledge gained from this study and re-examined some of the buildings they had seen with money they obtained from a history grant to study housing in the Top End of Australia.[18]

With additional funding Harris and Welke published 'Punkahs and Pith Helmets: Good principles of tropical house design.' The study was broken down into three parts: the regional context design components, and an application (Green Can). This study allowed Harris and Welke to further investigate the Top End region that had fascinated them so much in their previous study 'Influences in Regional Architecture.' The most important thing to recognize in the examination of the Green Can and Troppo's regional approach is

[17] Adrian Charles Welke, *Influences in Regional Architecture* (Adelaide: The Authors, 1978), 111.
[18] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 19-25.

their development of the design guidelines. The design guidelines are the translation of the research and regional contexts into architectural principles.[19]

Harris and Welke divided the design components down into three focuses: the house, the climate, and the structure. The house component revealed the interesting tag line 'a house is . . .' and isolated the numerous things a house should provide: Access; Support Services; Shelter and Comfort; Space to Do Things; Privacy; Places to Store Things; Adaptability; Social Contact; Environmental Association, and; Economic Determination. The climate component, an obvious extension of the climatic elements identified in the Kimberley region, proposed four fundamental architectural principles for making a house comfortable in the tropics without using air conditioners and fans. The four principles are: 1) the promotion of cooling breezes; 2) ventilation by convection; 3) reducing radiation heat, and; 4) sheltering of walls and openings. Lastly, the structure component identified essential elements of structural design that should shape the architectural detailing of a house. This included the four basic structural functions of bearing, span, bracing, and holding down. The structural component also suggested using construction as a framework for material selection. Choosing the purpose of a component (i.e. should a wall provide privacy, enclosure, or support) before building it is an opportunity to create an architectural effect. The structural component did not forget services such as electricity, water, and plumbing. Harris and Welke proposed, "instead of hiding them, take advantage of them and use them to characterize the design."[20]

To finish the study Harris and Welke included a design to demonstrate the principles they established. This design, of course, is the Green Can. Some time just after the construction of the Green Can and the establishment of Troppo Architects, Harris and Welke refined their architectural responses into a series of ten thematic constants. The

[19] Phil Harris and Adrian Welke, *Punkahs & Pith Helmets: Good Principles of Tropical House Design* (Darwin: Costless Printing, 1982), 2.
[20] Ibid., 22-53.

following principles have guided their architecture ever since but it is important to note that these principles are not rigidly fixed but are constantly evolving. Many of the previously discussed design principles can be recognized in the following 'ten thematic constants.'

The design of the Green Can truly demonstrated all of the design principles, currently known as the 'ten thematic constants,' developed by Troppo: 1) The Adjustable Skin, 2) Transported Materials, 3) Hearing the Rain, 4) House as Compound, 5) Bali Bathroom, 6) Nature, in The Territory, Looms Larger than Man, 7) The Natural Chimney, 8) The Inside-Outside House, 9) A House is …, 10) The Tenth Line.

THE ADJUSTABLE SKIN

Troppo's study, 'Punkahs and Pith Helmets,' of the Northern Australian region revealed the need and advantages of the adjustable building skin and created the first principle. "The example of architect Beni Burnett's louvered houses, the battens and folding shutters of the early 20th century slatted houses, roll-down blinds, the inventive use of shade cloth, and the laminating of roof eaves like the canopy of a tree all offered simple lessons."[21] These lessons formed the aesthetic and fundamental design principles that Troppo successfully employs in all their designs today. The use of 'adjustable skin' principles allows "the house to become an organism of adjustment, its skin like that of humans – an infinitely receptive tissue."[22] Adjustable Skin means designing so that not just the windows but doors, walls, floor and roof system can be adjusted to an almost infinite number of combinations. This allows light and air into the building at the users desired amount while protecting against intense winds and rain.

[21] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 243.
[22] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 104.

The Green Can was designed strongly around the adjustable skin principle with a central breezeway and a series of adjustable walls, windows and doors. All of the walls perpendicular to the wind were either louvers floor to ceiling or lattice allowing for maximum ventilation. Bedroom spaces had the most control over the amount of light and air coming into the space allowing the user maximum control of the interior environment. The central breezeway and living space were much more like a verandah in the amount they were exposed to the exterior environment with only lattice screens for walls in most areas.

TRANSPORTED MATERIALS

The idea of transported materials as the second design principle is an unexpected one considering Regionalism is defined by using the local context for design. Most people hear the word regional and assume materials must be of local origin. This misconception is where the ever-appropriate qualities of regionalism shine through. Regionalism is not Vernacular architecture, meaning designs can derive inspiration from any of the contextual forces of a region. Using a Regionalist design method does not mean materials have to be local, aesthetics and the form can be different. Troppo recognized the necessity of imported materials for the Northern Region of Australia. Their original study of Queensland revealed this as a contextual force because its influence on the identity of architecture in the region. "The use of corrugated iron, steel framing, plywood timber panels, fibre cement sheet, louvers, and the corresponding idea of the building as a prefabricated kit of parts, freely assembled and dissembled, informs their architecture."[23] Troppo recognized that transported materials were essential to the regions contextual fabric and they embraced it making it part of their architectural style. The region depends on imported materials for building as there are not enough locally available resources and access to transported materials is readily available. The sheet metal also works well with the climate.

[23] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 103.

The Green Can utilized the concept of transported materials. Using primarily timber and corrugated iron sheet metal the design depended on materials that were easily transported in from other regions. The Green Can also used a lightweight steel frame that reflects the concept of a prefabricated kit of parts.

'HEARING THE RAIN'

The climatic conditions of the Northern Territory of Australia are evident and reflected in the architecture of the third design principle. Troppo acknowledges the climatic elements of the subtropical region. They understand, like the inhabitants of the region, that there is no escaping the constant dripping of water off the roof overhangs. Rather than attempt to block out the natural phenomena, Troppo takes advantage of the 'wet' and 'dry' season by designing broad eave overhangs, deep shaded windows, steeply sloped roof, covered openings, and the use of connected indoor and outdoor space.[24]

There is no doubt that during the wet season the exposed interior ceiling and large roof overhangs of the Green Can supports the principle of hearing the rain. The sound of rain is amplified on sheet metal, it may even be overbearing during times of intense downpours.

HOUSE AS COMPOUND

This fourth design principle is based on the recognition that most houses grow. Guesthouses, decks, bathrooms and other additions eventually contribute to the house as a village or compound more than a single structure. Troppo designs houses that grow with varying degrees of privacy and openness creating space between the structures as outdoor rooms. The house becomes a community of rooms that act as the first filter to the heat and humidity of the region. This design principle represents innovation by

[24] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 244.

addressing a characteristic of the regions architectural identity then implementing it to create appropriate functional designs.[25]

The Green Can demonstrated this principle through the circumstances of the competition and the eleven other houses built together. The context and program of the Green Can did not ideally suite the building to demonstrate the full concept of the house as a compound but it did allude to the idea. The linear organization of the design would have made the Green Can easily expanded on without loosing the integrity of the design.

BALI BATHROOM

The fifth design principle Bali bathroom is implemented to take advantage of practical issues and the beauty of the landscape. Instead of enclosing the space and separating the person from the environment the Bali bathroom allows one to face and commune with nature. Practically, the bathroom solves problems of condensation and mold in a climate where moisture is a real problem for half of the year.[26] The word Bali refers to the simplistic but sophisticated Indonesian craft and openness of space.

The bathroom in the Green Can positions the user facing out to the landscape. This design principle may have been one of the weaker elements of the Green Can because it was not able to be as open as the concept intends. The basic intentions of the Bali bathroom were still accomplished through the adjustable louvers of the walls enclosing the bathroom from the exterior.

NATURE, IN THE TERRITORY, LOOMS LARGER THAN MAN

This sixth design principle acknowledges that the natural elements, of the Northern Territory, are unavoidable. The principle of design behind this understanding is to create

[25] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 244.
[26] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 103.

a structure that uses nature to filter nature instead of trying to create a retreat from the environment. Architecture that responds to keep out rain and the sun, to reduce heat, and to accommodate humidity makes the Top End livable. Dense plantings can help screen the natural elements such as bats, insects, dust, rain, wind, and water runoff. Modern architecture today usually aims to create an alternate environment from which to retreat out of the harsh or uncomfortable exterior conditions. Troppo realized through their research of the region that the architecture needed to provide relief from the elements but not remove an individual from them.[27]

The Green Can certainly did not remove people from the environment but unfortunately it did not adequately screen the natural elements. The chief complaint from people touring the Green Can was the dust infiltration and potential for spider webs. It may have been that in the context of a competition the siteing of the building and access to landscaping were limited. For this reason the Green Can may have failed in the attempt to use nature to buffer nature. However, the Green Can did show the importance of this design principle by not properly incorporating it.

THE NATURAL CHIMNEY

The natural chimney is the seventh design principle that utilizes the roof structure to maximize ventilation. "Troppo's inventive roof forms are not just an aesthetic exercise, but the means to an ecologically sustainable architecture."[28] The exposed underside and sloping planes of the Troppo roof allow the buildings to self ventilate. Instead of insulating the interstitial space between the roof and ceiling Troppo minimizes the roof cross section by exposing the underside. This technique decreases building cost, material usage, and construction waste; it also creates a thin building skin that expels heat quickly once the sun goes down.

[27] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 104.
[28] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 245.

The Green Can strongly incorporated the natural chimney into the design. The form and silhouette of the building with its steep opposing roofs can be credited to the principle of the natural chimney. Exposing the roof to interior combined with the steep angle of the roof increases the natural convection of air by exhausting hot air out of the building at the highest point. The exposed ceiling of the Green Can takes advantage of solar energy transferring heat from the roof to the air directly below increasing the rate of hot air exhausted and cool air drawn in through louvers and the lower level.

THE INSIDE-OUTSIDE HOUSE

As the name implies this eighth design principle blurs the lines between interior and exterior space. Troppo's methods of bringing the outside environment into the building begin to reinterpret the meaning of enclosed space. Spaced floor decking and level changes with open space to the outside produce a breathable architecture. Cross ventilation is key to the inside-outside house design principle but the means of cross ventilation is taking a step further with the floor plane. Instead of the traditional solid floor plane, Troppo maximizes the open space at the floor allowing significant ventilation.[29]

The Green Can did not include the concept of spaced flooring and level changes to incorporate ventilation but the design did make a strong connection between the indoor and outdoor space. The size and layout of the Green Can may have allowed for sufficient ventilation such that allowing air in through the floor plane was unnecessary to achieve the desired level of comfort for interior spaces.

[29] Philip Goad, *Troppo Architects* (Singapore: Periplus, 2005), 104.

A HOUSE IS. . .

Troppo's idea with this ninth design principle is looking at the house in terms of services. Identifying what the house needs to provide is better than trying to figure out what it is. This concept is rooted in ideas presented in the design components of 'Punkahs & Pith Helmets' describing what a house provides. This principle helps organize the design process and outcome to satisfy the basic needs a house should meet. A further meaning of this concept is that it represents indigenous architecture of a region.

The house is a representation of the elemental building typologies of the region such as a cave or lightweight aboriginal shelter. The basic concept of a house is something that one 'lives under.' Troppo's modern architectural manifestation of this principle is to elevate the house. An elevated house, among other things, creates that basic elemental space to live under. Roof overhangs or elevated verandahs are other ways to create the simple volume of space to live under.[30]

The Green Can demonstrated this concept in the basic covering of space. The design for all purposes is a roofed outdoor room that definitely reflects the basic elemental building typologies of the region. The design is simple both in program and the organization of the layout. Service space is on one side and living space on the other. The design serves the basic needs of the user without complicated wasteful amenities.

THE TENTH LINE

The tenth design principle, the tenth line, mandates theory and experimentation. In order to draw a three-dimensional cube in axonometric one has to draw nine lines. The tenth line immediately implies transparency. In reality the only way to see the tenth line would be if the volume were transparent or unenclosed. "Troppo's architecture demands the

[30] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 246.

investigation of the open frame and potentially unenclosed volumes. Space is extendible and also infinitely adjustable - if one allows the addition of the tenth line."[31]

In the Green Can the transparency of the structure demonstrated by the inside-outside living space is an exploration of the tenth line concept. Further adding to this concept was the light steel frame and open walls communicating a strong sense of transparency both literally and in perception of the mass of the materials. Heavy concrete and brick make one feel enclosed because of the dense qualities of the material whereas thinner materials have a transparent quality about them. Transparency is not just a visual phenomenon but can used to describe sound and feeling as well.

ANALYSIS

The following analysis examines the Green Can in terms of the client, the architects, and design. The design is then evaluated on the three topical conditions addressed more specifically by this research. The project will be evaluated on its regional qualities, sustainability aspects, and the designs cultural integration. The intent is to provide parallel information that compares the case studies done in this research to the focuses of this doctorate project.

The client for the Green Can is ultimately the residents and citizens of Darwin. The housing competition was intended to model innovative approaches to housing in the Northern Territory of Australia. Unfortunately, the timing for viewing the Green Can was less than optimal. Adrian Welke stated in an interview about the Green Can that, "It was the dry season, and the wind was ripping in from the south-east, just filling the houses up with dust . . . we had to sit there over the weekends and convince people that

[31] Philip Goad and Anoma Pieris, *New Directions in Tropical Asian Architecture*, ed. Patrick Bingham-Hall (Singapore: Periplus Editions, 2005), 246.

the [Green Can] is where they wanted to live."[32] Clients, despite obvious timing problems, recognized the appropriateness and deep rooted sense-of-place prevalent in the design. The designs integration with the harsh environment most likely related to the people living in Darwin who associate with the climate and landscape.

The citizens of Darwin that accepted and appreciated the design principles set forth in the Green Can eventually became clients of Troppo architects and as a result five variations of the Green Can were built in a place called Coconut Grove. Coconut Grove was an area of land located in a tidal surge zone that bared obvious consequences of living and building there. Building in Coconut Grove meant respecting the landscape and potential for extreme circumstances. The residents of Coconut Grove were willing to accept the level of comfort the Green Can provided with its passive ventilation strategy and connection to the environment. As a result the clients can be credited for the ultimate survival and success of the Green Can and design principles Troppo worked so hard to promote because they identified with the values reflected in the design.[33] The design reflected value of the environment and components of the region as they are.

Phil Harris and Adrian Welke formed Troppo Architects around the design principles they developed during their study of the Northern Australian region. Following these principles Troppo formed its uniquely expressed architectural philosophy as written by Phil Harris:

> *"Troppo is a national practice, regionally based aiming to develop regionally responsive architectures. For the place of each project, let's promote a Sense of Place: through an architecture that responds to climate and the local setting; a dynamic architecture of adjustable skins; that connects the indoors with the out (or should it be the outdoors with*

[32] Adrian Welke and Phil Harris, interview by Justin Clark, "Design Gone Troppo," *Houses*, (2002).
[33] Ibid.

> *the in?): a non-constant architecture that responds to the morning, the evening, the season, the heat, the cold, the sun, the rain – the moment that will never pass again. Troppo embraces the informality that is the Australian lifestyle." (Phil Harris and Adrian Charles Welke)*

Troppo's philosophy has come from a strong urge to create designs that embrace the place in which they are located. The Green Can clearly and uniquely represents Troppo's design philosophy.

The design of the Green Can was well executed considering the amount of design principles Harris and Welke were trying to tie together in one building for the first time. The integration of all the design principles should be noted. In most instances each design principle served to accomplish multiple principles. For example, the adjustable skin concept works to ventilate the space in unison with the roof as a chimney. It also connects the indoors with the outdoors and creates a feeling of transparency. The one design principle of adjustable skin helped at least three of the other design principles. The design demonstrates the value of integrated design strategies to achieve a goal.

Perhaps the only critique, of the design, would be of the seemingly unlivable conditions of the first variation of the Green Can. The principle 'Nature looms larger than man' was not adequately addressed and because of this the principles of the 'Bali bathroom' and the 'house as a compound' were not demonstrated to the full intention. Dust was a major problem with the design that may have been due to the limited budget or time for landscaping elements to grow. The Green Can may have just needed to be elevated enough to reach above the uncomfortable ground conditions. Considering almost all the proceeding variations of the Green Can were elevated this may have been a lesson learned from the design. Recognizing the way in which nature is able to buffer nature may not always be as obvious as vegetation. Finding the balance between what are

acceptable living conditions and the climatic conditions of the region is part of the process of designing regionally.

Harris and Welke recognized that the design had room for improvement based on the list of Good Principles of Tropical House Design they suggested in "Punkahs & Pith Helmets." The important aspect of the Green Can was that people reacted to it. The design was read differently by various groups of people, some people reacted positively and others negatively but regardless the design could be read. The design of the Green Can aimed to demonstrate the principles of tropical house design that Harris and Welke had worked so long to develop. This meant the design goal was to communicate a set of values based on design principles derived from various contexts of the region. For this reason, the fact that people understood the design as more than a house, Harris and Welke saw success that the Green Can could be interpreted. The local community understood the Green Can, as a set of values.

CONTINUITY – REGIONALISM, SUSTAINABILITY, CULTURAL INTEGRATION

It is being argued through this research that Regionalism, Sustainability, and Culture all reflect similar qualities and characteristics. The Green Can as it has been discussed is a very good example of regional design. In fact, it is probably too good because in most situations the architect would not have had the opportunity to research the region for nearly four years prior to design. Troppo captured the holistic approach needed for a sensible appropriate design that explores and strengthens the identity of a region through architecture. The Green Can addresses many of the contextual forces of the region and made them well understood giving the design a sense of place and identity with the region.

Troppo was positioned in way that allowed them to understand the region but also see the potential for reinterpreting the contextual forces into a modern architectural style. In the same way it is hard for one to recognize their own cultural characteristics, it is hard for one to recognize their own architectural style in a way that it can be explored. Troppo was new enough to the Northern region of Australia to have an *outsider's* fresh ideas and familiar enough to really understand the region and culture. In most cases the architect would probably not get the time to familiarize himself or herself with a region in the way Troppo did. That does not mean an attempt at regionally responsible architecture is impossible without years of studying the region. Troppo sets an example of the regional design method with their research, design principles, and demonstration of the design principles through the Green Can. The guiding principles of the Green Can were the Ten Thematic Constants discussed earlier but more specifically a connection to the specific qualities of the region. These qualities are a respect for the peculiar characteristics of the subtropical environment and the materials resources available to the area.

One example that can be followed by Troppo's work with the Green Can is that of design principles. There are numerous contextual forces prevalent at any given region but in order to interpret them into design one should first establish some design principles observed from the region. Troppo took simple observations of the region and developed design principles out of them. For example, Troppo observed that many of the structures in the region used materials that were imported from another region. They then took that observation and created the design principle of 'transported materials' that acknowledged the necessity of imported materials. Transported materials in terms of Regionalism are materials that either are not produced with the recognizable boundaries of a region or demand extensive transportation to make it available within the region. By incorporating the principle of transported materials, along with others principles, Harris and Welke developed a regionally appropriate design.

The community recognized the potential in the Green Can because of the effort Troppo put into regional design qualities with a whole-of-site approach. In terms of regional qualities the Green Can reached a deeper level of design that reflected the cultural values of the community. The Green Can was more than aesthetic qualities mimicking visual connection to the region it reflected spatial relationships of the culture to the environment.

The Green Can reflects a high level of sustainability when considering the six different categories of assessment of the LEED rating system: sustainable sites; water efficiency; energy and atmosphere; materials and resources; indoor environmental quality; and innovation of design. The design does not use any mechanical cooling or heating due to its passive solar design. The only electricity used is for lighting and ceiling fans. Almost all of the materials used are highly recyclable namely the light weight steel structure and corrugated iron cladding. The building itself has a minimal footprint only touching the ground with footing for columns. It has a tight building envelope using nominal dimensions to reduce construction waste. The design uses interior ventilation corridors, louvered walls, and sheet metal cladding to create a breathable structure. The Green Can itself did not employ rainwater catchment but many of the variations did because of the ease of implementation with metal roofing and an elevated structure.

Although the Green Can is naturally sustainable because of the regional design approach taken by Troppo, it could be more sustainable. The energy the building does use is such a small amount it could easily match or produce much more than it uses. The inclusion of on-site renewable energy such as wind or solar would make it not just efficient but effective with energy. The water and landscaping could be equally improved with the proper water collection and use. Materials could be taken a step further to insure the use of low emitting materials including paints and sealants. This would increase the indoor environmental quality. Altogether, the regional design approach takes a building much

higher on the sustainability scale than simply focusing on sustainability because the culture is addressed as well. A design that appeals to the culture of the immediate users and the community will be maintained. A building that is maintained has a Life Cycle far longer than any other building.

True integration of culture into a design is a very challenging task. More challenging is creating a culturally appropriate design that is innovative and modern. True integration of a culture's values is understanding the functional and spatial organization a culture has developed over the years. Architecture that reflects a cultures identity is not just aesthetic forms but the reason behind material choices, structural systems, building layout, site integration and many other seemingly normal architectural choices. Connecting rooms with hallways and corridors is a different expression of cultural values than room-to-room or using courtyards. The reason for different types of connections could be climatic or social but the culture is represented in often-mundane architectural distinctions such as these. Troppo's study of the Top End revealed many architectural characteristics such as open interior layouts and verandahs or large eave overhangs.

Troppo is fascinated with the idea of architecture as a shelter and bringing the outside in. This concept is based on the simplistic nature of the aboriginal huts, which were usually no more than cover. "The aboriginal shelter, apart from sacred cave sites, has been created only out of climatic response . . . because of this, aboriginal shelter exhibits a very simple translation of climatic principles."[34] Building on this basic principle Troppo drew inspiration from cultural values evident in the architecture throughout the region. The culture in Darwin recognized the values represented in the simplistic open-air design of the Green Can as something they could identify with.

[34] Phil Harris and Adrian Welke, *Punkahs & Pith Helmets: Good Principles of Tropical House Design* (Darwin: Costless Printing, 1982), 5.

The Green Can acted as a model for challenging a mixed set of cultural values with architecture. Troppo recognized and understood that the reasons for louvered walls, verandahs, and roof overhangs among the other architectural characteristics of the region, were because of people's response to the environment. The culture of the region, or at least the culture that identified with the environment, produced this recognizable pattern of architectural elements. Troppo took these elements and packaged them together in a new cohesive architecture demonstrated in the Green Can. The Green Can evoked two types of responses from the community, those that "lauded its appropriateness to climate and lifestyle" and those that "acted as though personally injured by moral values exuded by" the design.[35] Harris and Welke stated that the Green Can was hated by those who hated hate the local climate and loved by those who enjoy the peculiar qualities of tropical existence. The Green can was either a symbol of "retrogression to the marvelously comfortable, plugged-in society;" or an iconic structure descriptive of a tropical house for the region.[36]

The Green Can stirred discussion about the community's value of place and suggested a means for identifying with the region. Based on the request for five more variations of the design, the culture was able to identify with the values portrayed in the Green Can. Harris and Welke summed up the Green Can best in their statement:

> *The Green Can is original. There has never been anything like it in the Top End. But it also deliberately borrows from houses of the past. Houses in the Northern Territory were built to suit local conditions. Many people hate it. They worry about cobwebs gathering and dust getting in. But many others love it. They think it fits in with the climate and lifestyle of the tropics. (Harris & Welke, 1982)*

[35] Phil Harris and Adrian Welke, *Punkahs & Pith Helmets: Good Principles of Tropical House Design* (Darwin: Costless Printing, 1982), 55.
[36] Ibid., 56.

CHAPTER 2

DEFINING SUSTAINABLE ARCHITECTURE

> *"Transformation to an eco-effective vision doesn't happen all at once, and it requires plenty of trial and error—time, effort, money, and creativity expended in many directions."*
>
> (William McDonough & Michael Braungart, 2002)

Sustainable architecture has come to mean much more than an architecture that sustains or supports itself. Perhaps this is why there are several different names for sustainable architecture such as Environmental design, Green design, and Ecoism. Sustainability is a general term that describes environmentally conscious design techniques. Sustainability in the broadest sense is the ability to maintain a certain process or state at a given level. In architecture this refers to the ability of a building to maintain its functions and extends to the materials used for a project and the construction process. All of the terms referring to sustainability are more or less personal choices as to what term one feels best describes the movement. The architectural style or movement of Sustainability is an effort towards environmental responsibility. "Sustainability demands a holistic approach to given physical conditions, from climatic conditions such as latitude, rainfall and prevailing winds, to the micro level of individual details."[1] Sustainability is more like a design method than an architectural style because like Regionalism it can be applied to almost any building type with no expected visual form.

[1] Jeremy Melvin, *Isms: Understanding Architectural Styles* (New York: Universe Publishing, 2006), 136.

The advent of different definitions existing within the sustainable movement has not yet developed into clear differences. Ecoism is an approach to conservation that "seeks a rationale for design innovation in principles of sustainability."[2] It is a philosophy focused on the healing of mother earth. On the other hand, Green design is a term more commonly used in political settings and refers to sustainability as set forth in today's modern assessment systems for sustainability. The ASHRAE GreenGuide defines green design as "design that minimizes the negative human impacts on the natural surroundings, materials, resources, and processes that prevail in nature."[3] There is some difference between the terms green design and sustainable design and that is the degree to which the design maintains ecological balance. Environmental design is another term referring to sustainability but it is similarly a general term also referring to environmentally conscious design techniques on the whole.

Sustainability has more quantifiable aspects than appearance, which is why assessment systems have been established to evaluate designs. Sustainability, by contrast to Regionalism's provision of identity, is justified by a moral imperative of environmental responsibility. This imperative more commonly gets translated into assessable aspects like energy efficiency and material innovation. Sustainability is pursued based on cultural values. Regardless of form and aesthetics sustainable design strategies reflect the values of culture making sustainability a style people can identify with and interpret meaning. Sustainability is primarily focused on reducing the environmental impacts of buildings. Sustainability produces healthier buildings that benefit the environment through responsible uses of natural material and energy resources.

[2] Jeremy Melvin, *Isms: Understanding Architectural Styles* (New York: Universe Publishing, 2006), 136.
[3] D.L. Grumman, ed., *ASHRAE Green Guide: The Design, Construction, and Operation of Sustainable Buildings*, ed. D.L. Grumman (Atlanta, Georgia: ASHRAE, 2006), 4.

2.1 ASSESSMENT SYSTEMS

The ability to assess the sustainability of a building, or more appropriately a project which would include not just the building but also the surrounding site and region, is an important function. Several green building rating systems have been developed to objectively evaluate energy and environmental performance that spans the broad spectrum of sustainability.[4] Three primary assessment systems are Building Research Establishment Environmental Assessment Method (BREEAM), Green Building Initiative's (GBI) Green Globes, and Leadership in Energy and Environmental Design (LEED). The organization of these systems helps to identify Sustainability and consequently reveal the direction and focus of the movement.

The Building Research Establishment Environmental Assessment Method (BREEAM) is the earliest building rating system establish for environmental design. Created in the 1990 by the British Research Establishment, BREEAM is recognized by the U.K. building industry as a standard for evaluating environmental performance.[5] Being the first widely recognized sustainability assessment system made BREEAM a model by which several other countries have developed variations from. BREEAM originated as a simple design checklist then later developed into a more comprehensive design tool. BREEAM never made it to the U.S. but it does retain the recognition as a founding assessment system for sustainability. Notably, BREEAM can be accredited for the development of LEED and Green Globes both of which are substantially based on the BREEAM system.[6]

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[4] Krishnan Gowri, "Green Building Rating Systems: An Overview," *ASHRAE Journal*, November 2004: 56-59, 56.
[5] Ibid.
[6] Timothy M. Smith, Miriam Fischlein, Sangwon Suh and Pat Huelman, *Green Building Rating Systems: A Comparison of the LEED and Green Globes Systems in the US*, University of Minnesota (St. Paul: The Carpenters Industrial Council , 2006), 2.

Leadership in Energy and Environmental Design (LEED) was created and introduced to the U.S. in 1998. "In North America, the U.S. Green Building Council (USGBC) developed the LEED rating system with a market-driven strategy to accelerate the adoption of green building practices."[7] The system was developed around the use of existing proven technology. This strategy has been successful in the adoption of the assessment system by several states, federal agencies, and local jurisdictions as a requirement for large projects.

The LEED rating system "evaluates environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a 'green building.'"[8] LEED evaluates sustainability through six major categories, which are Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality (IEQ), and Innovation & Design Process. There are four levels of certification; Certified (26-32 points), Silver (33-38 points), Gold (39-51 points), and Platinum (52-69 points), based on points earned in each of six categories.[9]

Each of the LEED categories are intended to emphasize various design strategies that address specific environmental impacts inherent in the design, construction, and operations and maintenance of buildings. The Sustainable Sites category is intended to encourage development and preservation or restoration practices that limit the environmental impact of buildings on local ecosystems. This category offers 14 possible points and has one prerequisite, which is construction activity prevention. The Water Efficiency category is intended to reduce the use of fresh water by buildings, reuse wastewater were possible, and manage runoff water on site in an effort to reduce the

[7] Krishnan Gowri, "Green Building Rating Systems: An Overview," *ASHRAE Journal*, November 2004: 56-59, 57.
[8] U.S. Green Building Council, *New Construction Reference Guide: Version 2.2*, 3rd Edition (Washington D.C.: USGBC, 2007), 14.
[9] Ibid., 17.

environmental impact on the natural aqua systems. This category offers 5 possible points and has no prerequisites. The Energy & Atmosphere category is intended to reduce the amount of energy required by buildings resulting in reduced consumption of fossil fuels and fewer carbon emissions released into the atmosphere. This category offers 17 possible points and has three prerequisites, which are fundamental commission of the building energy systems, minimum energy performance, and fundamental refrigerant management. The Materials & Resources category is intended to encourage the use of materials that are environmentally responsible in the extraction, processing, and transportation steps required to process them. This category offers 13 possible points and has one prerequisite, which is storage and collection of recyclables. The Indoor Environmental Quality category is intended to encourage the use of materials that release fewer harmful chemical compounds and increase ventilation, day lighting, and temperature control. This category offers 15 possible points and has two prerequisites, which are minimum indoor environmental quality performance and environmental tobacco smoke control. The last category Innovation and Design Process is intended to address the constant change in sustainable design strategies and technology. This category offers 5 possible points and has no prerequisites.[10]

In 2006 LEED offered online services enabling teams to submit 100 percent of their documentation online. Previously, LEED tended to be more rigid, time-intensive, and expensive to enact due to its primarily paper based system, in comparison to other rating systems.[11] LEED certification is not something that can be achieved without professional help. LEED does recognize that the field of sustainability is changing daily and rightfully makes change to accommodate new technologies and design strategies. Unfortunately, the constant evolution of LEED is confusing and makes it difficult for

[10] U.S. Green Building Council, *New Construction Reference Guide: Version 2.2*, 3rd Edition (Washington D.C.: USGBC, 2007), 21-395.
[11] Timothy M. Smith, Miriam Fischlein, Sangwon Suh and Pat Huelman, *Green Building Rating Systems: A Comparison of the LEED and Green Globes Systems in the US*, University of Minnesota (St. Paul: The Carpenters Industrial Council , 2006), 3.

people new to the system to understand it. An assessment system called Green Globes is the reciprocal to the complexity of understanding LEED. Green Globes developed a much more intuitive system of assessment for the average person.

In 2005 the Green Building Initiative (GBI) launched Green Globes by adapting the Canadian version of BREEAM and distributing it in the U.S. market."[12] Green Globes is very similar to LEED; there are seven assessment categories that are: Project Management, Site, Energy, Water, Resources, Emissions Effluents & Other Impacts, and Indoor Environment. Additionally, Green Globes offers four levels of certification that are: One (1) Globe, Two (2) Globe, Three (3) Globe, and Four (4) Globe.[13]

Green Globes is made much more available to the average person as an assessment system. "Green Globes' simpler methodology employs a user-friendly interactive guide for assessing and integrating green design principles for buildings."[14] There is less need for a professional to implement a sustainability assessment using Green Globes because of its online yes/no questionnaire format.

According to an AIA Study of Three Green Building Systems, "Green Globes has a greater focus on energy efficiency than LEED but needs more stringent and specific requirements."[15] The advantage Green Globes provides with its user-friendly on-line assessment system is immediate feedback allowing for better integration into the design process. Green Globes can be used for self-assessment or third party verification. The

[12] Timothy M. Smith, Miriam Fischlein, Sangwon Suh and Pat Huelman, *Green Building Rating Systems: A Comparison of the LEED and Green Globes Systems in the US*, University of Minnesota (St. Paul: The Carpenters Industrial Council , 2006), 2.
[13] Green Globes, *Home Page*, http://www.greenglobes.com (accessed October 8, 2008).
[14] Timothy M. Smith, Miriam Fischlein, Sangwon Suh and Pat Huelman, *Green Building Rating Systems: A Comparison of the LEED and Green Globes Systems in the US*, University of Minnesota (St. Paul: The Carpenters Industrial Council , 2006), 3.
[15] AIA Sustainability Discussion Group, "Quatifying Sustainability: A Study of Three Sustainable Building Rating Systems and the AIA Position Statement," *AIA*, May 2008, http://www.aia.org (accessed October 21, 2008), 4.

system often encourages various sustainable design strategies but has no specific requirements for certification.

All three assessment systems have contributed to a better understanding and comprehensive approach to sustainability. BREEAM laid the foundation for future assessment systems to model themselves from and as such is credited for the development of LEED and Green Globes. Both LEED and Green Globes are assessment systems that recognize the necessity to evolve and update with the advent of new sustainable strategies and technology. This understanding is the reason sustainable assessment systems continue to be a valuable resource. Systems cannot be perfect, however, there will always be room for improvement. There are several aspects of sustainability that are overlooked that could effectively improve the goals of sustainable design.

2.2 OVERLOOKED DYNAMICS OF SUSTAINABILITY

Sustainability tends to overlook some of the important contexts of a design on its quest for energy efficiency. The rating systems and organized checklists that have begun to dominate the movement are getting too caught up in standards of performance. "The AIA supports the development and use of rating systems and standards that promote the design and construction of communities and buildings that contribute to a sustainable future."[16] The standards of these rating systems are narrowly focused on quantifiable aspects of design.

There are many positive aspects to sustainability rating systems. These rating systems contribute significantly to the development and promotion of sustainable technologies,

[16] AIA Sustainability Discussion Group, "Quatifying Sustainability: A Study of Three Sustainable Building Rating Systems and the AIA Position Statement," *AIA*, May 2008, http://www.aia.org (accessed October 21, 2008), 2.

materials, and practices. It should be recognized however, that quantifiable aspects are not all that contributes to a design. Most of the overlooked aspects of design in sustainability are those that are hard or nearly impossible to quantify. It is these aspects that can ultimately contribute the most to increased sustainability.

There are four overlooked areas in particular that this research will discuss: Aesthetics, Functionality, Culture, and Historical Context.

Aesthetics are one of the first overlooked aspects to sustainable design. Even though the architect knowingly designs with the visual appearance in mind it is all too easy to become focused on performance. Each piece of the design is analyzed and assessed as to its ability to earn points in a rating system. Visual appearance is sacrificed in lieu of performance.[17] The shape and form imperative to architecture gets lost in the function. This issue will be discussed later as it is not just an overlooked dynamic of sustainability but a significant challenge to movement.

The value of good aesthetic qualities is largely misunderstood in terms of sustainability. Aesthetics is just one piece of a design, a building's sustainability can benefit from the functional aspects of the design as well. Functionality is another overlooked dynamic of sustainability.

To avoid confusion functionality being discussed here is not the same as performance referred to in Life Cycle Assessment (LCA), which measures the full impacts of a product or service from its production to disposal. The functional qualities of a design pertain to the order of space. Poor functionality can be seen when furniture does not fit well in rooms, there is little to no storage space, and the spaces are too tight to allow necessary movement.

[17] Jeremy Melvin, *Isms: Understanding Architectural Styles* (New York: Universe Publishing, 2006), 139.

The reason function is a relatively unaddressed aspect in assessment systems and sustainability in general is because building efficiency often increases with smaller spaces. The smaller a building is the smaller its environmental impact is in almost every aspect from materials, energy, and water use to the building footprint. However, a smaller building does not necessarily equal a sustainable practice. Buildings that have poor functionality are less likely to be maintained and as a result experience significantly reduced life cycle. This wastes the materials and energy used for the building because unless the materials have a high recyclability their useful potential is cut short.

LCA deals primarily with materials and resources with less focus on the building as a whole. The functionality described in LCA pertains to the performance and impact of individual materials.[18] This aspect is consequently overlooked in sustainability but some of the assessment systems are addressing this aspect. LCA is more appropriately a challenge to sustainability than an oversight. LCA is a detailed assessment of individual products, which currently does not consider products together making a larger product such as a building. This issue like aesthetics is also discussed later as it is a significant challenge to sustainable movement.

The last two overlooked dynamics of sustainability to be discussed are the most difficult aspects to quantify. Culture and Historical Context are very influential components of sustainable design yet assessment systems have no way of measuring the benefits. If buildings were not used by people and just needed to sustain themselves then culture would not be important. However, buildings exist because people design, build, and use them making the integration of cultural characteristics an essential piece to the sustainable puzzle.

[18] Scientific Applications International Corporation, *Life Cylcle Assessment: Principles and Practice*, Office of Research and Development, U.S. Evironmental Protection Agency (Cincinnati: EPA, 2006), 1.

Sustainability in the fullest sense is a broad design approach that considers all the aspects of project and their environmental impacts. Similarly culture is essentially every aspect of the human condition. Culture describes a community's values, beliefs, and traditions manifested through patterns and various expressions. Architecture is an important expression of cultural values; as such sustainability is a representation of values. Culture can be expressed through sustainable design strategies. Sustainability often misses the connection between culture and architecture, and the assessment systems fail to address it. It is not a fault of the sustainable movement that culture is not addressed better by assessment systems because the real emphasis is on efficiency.

A building that embodies cultural values that people can find identity in will have a longer life cycle due to care and maintenance. Buildings that appropriately addresses culture increase their endurance through care provided by the people. There is a direct relationship between sustainable choices and cultural values.

2.3 EFFICIENCY VS EFFECTIVENESS

Efficiency is the ratio of something's performance in contrast to the amount of energy and/or materials used. Effectiveness is the ability of something to produce desired results, which may result in an abundance of usable materials/energy. William McDonough and chemist Michael Braungart's "waste equals food" concept discusses the importance and potential of efficiency verses effectiveness. In their book "*Cradle to Cradle: Remaking the Way We Make Things*" a sharp contrast is made between the path sustainability is taking and the path perhaps it should.

McDonough and Braungart bring up a crucial point that effectiveness is far more important than efficiency. Sustainable design, as it is seen by the assessment systems, is unfortunately heavily focused on efficiency. Efficiency is a very limited term, when

taken literally it means to use the least amount of energy and/or resources necessary to continue an action thus making zero the best solution. As McDonough and Braungart put it, "Is our goal to starve ourselves? To deprive ourselves of our own culture, our own industries, our own presence on the planet, to aim for zero?"[19] It's funny how one minute zero carbon emissions can seem like such an accomplishment then the next such a waste. Limiting ourselves can only take us so far but creating and producing the things we like and use in abundance would remove the limits of efficiency. Efficiency is an important component in achieving an effective sustainable design but it should not be the primary goal. For buildings, in most instances, it is necessary for components to be efficient so that entire systems can be effective by producing more than needed. For example the use of photovoltaic's for clean renewable energy production can be a very effective system if the lights, appliances and other electrical devices using the energy are efficient. This could create a situation of excess that can then benefit more people.

Effectiveness can also be understood as making use of the inefficiencies in a product or system. For example the heat generated from motors or electrical systems can be collected to either heat something else or be used as energy for a different purpose. Effective design understands the uses of something beyond its first use. Recycling is the best example of using something for a secondary purpose. Waste can be a resource instead of a negative force.

McDonough and Braungart state that their "concept of eco-effectiveness means working on the right things—on the right products and services and systems—instead of making the wrong things less bad."[20] Their concept is entirely based on nature and the products, emissions, and wastes things like the abundance of fruit and leafs trees create. Nature is all but efficient although it is effective when almost every natural thing produces far more

[19] William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (New York, New York: North Point Press, 2002), 90.
[20] Ibid., 76.

than it needs. For example a fruit tree produces an abundant amount of fruit compared to what it needs to propagate itself. Most of the fruit that is waste for the tree is food for something else like us, animals, or even the earth as it decomposes. In the same sense McDonough and Braungart argue that our buildings should be designed with effectiveness as the goal as opposed to efficiency. Efficiency does not create it limits.

McDonough and Braungart see a world of abundance, not limits. Instead of looking at how to reduce the human ecological footprint, they have a different vision. "What if humans designed products and systems that celebrate an abundance of human creativity, culture, and productivity?"[21] This is all not to say that sustainability missed its opportunity but perhaps there is a different design method that could better address sustainability. The "waste equals food" concept is more than just architecture. To truly implement the concept of eco-effectiveness more than just architecture would need to change, industry would have to change as well.

Industry would have to change because sustainability is dependant on the entire process of harvesting, creating, packing, shipping, installing, using, and disposing of a product. This is why LCA is an integral piece to effective sustainability. Sustainability is almost useless without the availability of environmentally responsible materials. Architecture needs to promote the use of environmentally responsible products to help industry change to more effective products and practices. Effectiveness is a good principle to aim for when so much of sustainability is focused on efficiency.

[21] William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (New York, New York: North Point Press, 2002), 15-16.

2.4 CHALLENGES

Sustainability like any other design focuses has challenges. The following five areas are things that could be improved upon in the current practice of sustainability: Life Cycle Assessment, Return on Investment, Aesthetics, Building Code, and the Integration of Culture. The Life Cycle Assessment (LCA) of a material looks at performance for the entire use and its environmental impacts not just at production. This complimentary assessment system has not been incorporated enough into the sustainable design assessment systems LEED and Green Globes. The return on investment for sustainable products and strategies is a challenge to the sustainable movement because it does not equally compare the benefits of each. Aesthetics, which have been proven to increase the sustainability of a product, are not given a strong emphasis in sustainable designs. This is retroactively working against the progression of sustainable design. The systems for assessing sustainability are caught between voluntary use and required code for buildings. Change is needed to promote the implementation of sustainable design practice and products but it must be careful not to suppress innovative strategies by over regulating. Finally, the integration of culture into the practice of sustainability is not a conscious effort despite its unavoidable influences on design and architecture. Sustainability could increase its effectiveness through appropriate integration of cultural values into designs and sustainable strategies.

First, Life Cycle Assessment could best be described as a filter or screen for the sustainable movement. LCA examines every product to assess its individual sustainability from production to alternative uses to disposal. LCA determines the environmental impacts possible at every stage of a products useful life. This means assessing the impacts of a products production, use, and even the environmental effects of its disposal. Long product life spans do not equal a high LCA as life span is only one piece of a products overall environmental impact. LCA is easier to apply to singular

products that are not made of multiple components. Buildings for this reason are not as accurately assessed because of the complexity of components. "Green building design challenges designers to go beyond the codes to improve overall building performance, and minimize life-cycle environmental impact and cost."[22] LCA is crucial to the concept of effectiveness over efficiency. In terms of sustainability LCA is half the battle. LCA examines the building blocks for a sustainable future.

LCA is a "Cradle-to-Grave" approach for assessing products. It consists of four components: goal definition and scoping, inventory analysis, impact assessment, and interpretation.[23] LCA is essentially an assessment system for individual materials. The goal is to provide architects, contractors, and other professionals with a system for comparing and choosing environmentally sustainable products. This saves architects the time of evaluating the sustainability of individual materials while also trying to evaluate their design. This also helps standardize assessments for equal comparison of products.

The challenge to sustainability is developing and incorporating LCA both from an individual product perspective and the ability to assess an entire building. Both of the dominating rating systems in the U.S., LEED and Green Globes, does not sufficiently address LCA.[24] Each system is not providing enough points in the rating systems to encourage the use of highly sustainable products. LEED for example offers a total of 13 points in the category of materials. Most of the points available in that category are attainable through the use or specification of materials either made from recycled content or marinating a high level of recyclability. None of the 13 available points give direct credit for use of a product with a high LCA. While recycled material is good it does not

[22] Krishnan Gowri, "Green Building Rating Systems: An Overview," *ASHRAE Journal*, November 2004: 56-59, 56.
[23] Scientific Applications International Corporation, *Life Cylcle Assessment: Principles and Practice*, Office of Research and Development, U.S. Evironmental Protection Agency (Cincinnati: EPA, 2006), 2.
[24] Timothy M. Smith, Miriam Fischlein, Sangwon Suh and Pat Huelman, *Green Building Rating Systems: A Comparison of the LEED and Green Globes Systems in the US*, University of Minnesota (St. Paul: The Carpenters Industrial Council , 2006), 19.

fully take into account the environmental impacts of that product, which is what LCA focuses on. LCA is not perfected by any means as it continues to develop like all other assessment systems as new products and technologies become available. A better integration of green building rating systems and LCA will increase the sustainability of architecture.[25]

The environmental impacts that can be successfully reduced by incorporating materials with high LCA ratings would champion industrial change and architectural performance. Change is slow at first and requires multiple actions to occur simultaneously but eventually it will pick up momentum and become its own engine. However, Life Cycle is only one aspect of sustainability. Sustainable design needs to keep a holistic approach in order to be the most effective.

Second, the term return on investment (ROI), commonly referred to as payback, is used to describe the length of time before financial savings from sustainable devices equal the initial cost of the product or strategy. While this is an enticing mechanism for garnering support and increasing the feasibility of sustainable strategies, it can also become hindrance to making the best sustainable choices.

ROI can be viewed as a measure of effectiveness. A product that is ether producing more than is demanded or using less is a form of effectiveness when compared to a standard product because of the financial savings. Unfortunately ROI is limited to the promotion of products and strategies that can be directly quantified in financial terms. This means that things that are not evaluable by direct comparison of financial savings to another product can be quickly overlooked. The financial benefit of choosing materials that use less harmful chemical compounds thus emitting less volatile gases may not be easily

[25] AIA Sustainability Discussion Group, "Quatifying Sustainability: A Study of Three Sustainable Building Rating Systems and the AIA Position Statement," *AIA*, May 2008, http://www.aia.org (accessed October 21, 2008), 1-2.

evaluated. Not choosing safer materials could cause unforeseen health problems and result in irreconcilable damage both financially and personally. The financial aspect overlooks the intended purpose of sustainability, which is environmentally conscious design. As a result ROI can be a hindrance to sustainability.

Third, aesthetics is not just an overlooked aspect of sustainable design; it is a major challenge to the movement. There are two sides of the spectrum, those that want to see the sustainable features and those that don't. Renzo Piano is a well-recognized architect who has designed some of the most innovative buildings seen today with high levels of sustainability. His work includes the Tjibaou Cultural Centre, Paul Klee Center, and the California Academy of Sciences building that do not sacrifice aesthetic appeal over practicality. Cathleen Mcguigan in referencing Renzo Piano's comments on the narrow perception of sustainability states, "sustainability is about the practical systems of a building, not the beauty of great design."[26] The truth of this statement is the challenge facing sustainability.

Unfortunately, the aesthetics of sustainability can be very raw and unrefined. Mcguigan argues that seeing odd, sometimes mechanical looking buildings that scream sustainability repulses some people. On the other hand, some people like to see the gadgets and technology because it makes the building intriguing and meaningful to them. Aesthetic beauty has a subjective component to it but beauty has universal understanding. There is no reason that sustainable buildings cannot be aesthetically pleasing in fact, sustainability can benefit a great deal from appropriate attention to aesthetics.

"A beautiful building will be kept by a culture much longer than an ugly building."[27] In fact a level of sustainability is achieved simply by making a building look good.

[26] Cathleen Mcguigan and Daniel Stone, "The Bad News About Green Architecture," *Newsweek*, September 15, 2008: 77-78.
[27] Leah B. Garris, "A Smart Approach to Sustainability," *Buildings*, March 2007: 44-45.

Sustainability does not have to hide itself in order to please one group of people or expose all the technology to please another. A design that is informed and considerate of all the contextual forces relating to the project and site has the best opportunity to achieve high sustainability.

Finally, seven categories of aesthetics were identified by a group of researchers, Javad Zafarmad, Kazuo Sugiyama, and Makoto Watanabe, which seem affective for promoting product sustainability. "These aesthetic attributes are: 'aesthetic durability'; 'aesthetic upgrade-ability and modularity'; 'simplicity and minimalism'; 'logicality and functionality'; 'natural forms and materials'; 'local aesthetic and cultural identity'; and 'individuality and diversity'"[28] Each of these attributes identify qualities that both individually and combined appeal to people. For example a car that uses plastic for its exterior panels though easily modified, falls short on durability and natural forms and materials. It is important to demonstrate the range of aesthetic categories that can have an effect on a product. Any of these seven aesthetic attributes has the potential of increasing or decreasing sustainability. With this broad reach its no wonder aesthetics are challenging sustainability especially when aesthetics are not given a strong focus.

Fourth, laws and building codes have a profound impact on sustainability. They can either work to promote sustainability through awareness and incentives or stifle it by over regulation and no room for innovation. Cathleen Mcguigan stated, "I look forward to a future when green architecture won't be discretionary but required of every architect and builder."[29] That simple statement captures the truth of the sustainable design movement. Sustainability is a design movement not a law and because of that only an architect, contractor, or client that wants sustainable design requires it. There are positive and

[28] Seyed Javad Zafarmand, Kazuo Sugiyama and Makoto Watanabe, "Aesthetic and Sustainability: The Aesthetic Attributes Promoting Product Sustainability," *The Journal of Sustainable Product Design* (Springer Netherlands), December 2003: 173-186.
[29] Cathleen Mcguigan and Daniel Stone, "The Bad News About Green Architecture," *Newsweek*, September 15, 2008: 77-78.

negative aspects to keeping sustainable design strategies and products a personal choice. Positively this allows anyone or business to pursue different design techniques and products without fear of regulatory intervention. The basic concept of competition is allowed to work and hopefully the better product wins and not the better advertisement or monopoly. Negatively, personal choice regarding sustainability does not ensure progress. In any given situation personal gain will most likely be placed above the greater good such as choosing the cheaper product.

All green building rating systems were initially voluntary and often got used as checklists instead of goals to meet and exceed.[30] Time will only tell if sustainable design policies become mandated. Perhaps sustainability will be a significant part of the building code in the future. Currently multiple states around the nation are starting to mandate levels of sustainability. Most states along with the Federal Government give incentives for implementing sustainable products and technologies already. In major urban markets like New York and Boston, almost all new commercial construction projects meet some level of green design.

In 2005 Legislature established Act 8, which created the Hawai‘i 2050 Sustainability Task Force tasked with reviewing the State Plan and creating a Sustainability Plan. The Task Force is a group of 25 citizens with a diverse range of experience in planning, community, business, the environment and government. The team developed the following definition of Sustainability for Hawai‘i:

> A Hawai‘i that achieves the following:
>
> - Respects the culture, character, beauty and history of our state’s island communities

[30] Krishnan Gowri, "Green Building Rating Systems: An Overview," *ASHRAE Journal*, November 2004: 56-59.

- Strikes a balance among economic, social and community, and environmental priorities.
- Meets the needs of the present without compromising the ability of future generations to meet their own needs.

The plan took two years to complete and was revealed to State lawmakers in early 2008. The plan has various goals broken into time frames, which include increasing affordable housing opportunities, reducing the state's use of fossil fuels and increasing recycling. The plan is well intentioned but so far no new laws have been passed as a direct result of the 2050 Sustainable Task Force. The plan has increased awareness of sustainability in the Islands, specifically among lawmakers. It should be noted that the definition of sustainability created mentioned and placed culture, character, beauty, and history first. This recognizes the importance of all the contexts of a region in the overall sustainability that can be achieved.[31]

Hawai'i currently requires all government-funded buildings to achieve a LEED rating. Hawai'i will also be the first North American State to require solar water heaters in new homes. In June of 2008, Governor Linda Lingle of Hawai'i approved Senate Bill 644, which requires all building permits for single-family homes issued after January 1, 2010 to include solar water heaters.[32] There are positive and negative aspects to this Bill. Positively, this Bill helps initiate statewide practice of sustainability while saving significant amounts of energy demanding of the individual Islands power plants. Unfortunately, the Bill did eliminate a 35 percent tax credit and $1,000 HECO rebate for residential developers and homeowners who install solar water heaters, although this issue is reportedly being addressed in the next legislative session.

[31] Hawai'i 2050 Sustainable Task Force, *Homepage*, http://hawaii2050.org (accessed January 2, 2009).
[32] Rob Shikina, "First-in-Nation Solar Law Comes with Concerns," *Star Bulletin*, June 27, 2008.

It would appear that required law is replacing the "honor system" of voluntary sustainable design. The impact that might have on design could create a large cultural shift and change the face of architecture. The building code is in place with exclusive purpose of providing safe buildings for people. The building code is not concerned with aesthetic appearance or innovative designs. The building code is concerned with the protection of human life. This means that sustainability is being considered a form of health and safety not just financial savings. Building codes set levels of quality that buildings have to meet. Sustainability is proving that these standards are not high enough. It seems reckless to suggest building codes should demand higher levels of performance quality because regulation often becomes a box limiting the exploration of alternate design strategies. Hopefully, sustainable strategies will help to refocus the true intentions of building codes.

The overlooked aspects of sustainability will become an even bigger issue if not addressed as the movement progresses. Regionalism has the potential for effectively improving the goals and intentions of sustainable design. Regionalism could help sustainability to include a more holistic design approach that appropriately addresses the less quantifiable aspects such as aesthetics, spatial relationships, historical context, and regional cultural values.

2.5 CASE STUDY – SUSTAINABILITY

The following case study is an example of the process and product of sustainably focused design. This case study shows the product and level of sustainability a design can achieve when emphasizing environmentally responsive design strategies and technology. This study is intended to examine the characteristics of a highly sustainable design and analyze the continuities between Sustainability, Regionalism, and Culture.

Key Parameters

Project Name:	Hawai‘i Gateway Energy Center (HGEC) visitor complex	
Location:	Kailua, Kona: Big Island of Hawai‘i	
Architect(s) / Firm:	Bill Brooks / Ferraro Choi and Associates	
Date of Completion:	October, 2004	
Gross Square Footage:	3,600 Square Feet	
Cost:	$3,400,000 (Land Excluded)	
Program:	Indoor Spaces:	Offices, Conference Facilities, Labs, Visitors’ Center
	Outdoor Spaces:	Parking, Restored Landscape, Drives/Roadway, Patio/Hardscape, Interpretive Landscape
Construction:	Masonry and Steel Truss Space Frame	
Building Type(s):	Commercial Office, Assembly, Interpretive Center, Classified Urban (Coincidentally, isolated seven miles from nearest urban population.)	
Sustainability Rating:	Zero Energy Building Platinum (52 Points) U.S. Green Building Council LEED-NC v.2.1	
Design Approach:	Achieve a High Level of Sustainability	

ABSTRACT

The Hawai‘i Gateway Energy Center (HGEC) visitor complex at the Natural Energy Laboratory of Hawai‘i (NELHA) is a model for sustainability in the Hawaiian Islands. Located on a barren landscape of an old lava flow on the south coast of Kona on the Big Island of Hawai‘i, the HGEC is a technological example of site integration used for increased sustainability. The HGEC was built at a cost of approximately $3.5 million with donated photovoltaic panels and the unique use of seawater provided at cost by the state. HGEC uses a large steel truss system to support several sets of photovoltaic panels and shade entry and walkways. The design aesthetic and form is clearly reflective of its functional qualities strongly portraying technological innovation.[1]

The HGEC was not originally intentioned to achieve a Leader in Energy and Environmental Design (LEED) certification level but resulted in a Platinum certification. Achieving the highest level of certification offered by LEED was a result of team collaboration. “With support of the client, the architecture and engineering team envisioned a facility that would merit national recognition while contributing to the local community.”[2] Architect Bill Brooks, of Ferraro Choi and Associates, and mechanical, electrical, and plumbing (MEP) engineer and energy consultant Shayne Rolfe of Lincolne Scott worked in concert from the beginning to achieve the successful integration of sustainable design strategies. HGEC uses over 20 sustainable design strategies including day lighting, induced ventilation, passive cooling, and condensation irrigation.

[1] Tristan Roberts, "Hawai‘i Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71, p66.
[2] USGBC, "LEED Case Study: Hawaii Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).

Figure 2.1 Hawai'i Gateway Energy Center, 2007[3]

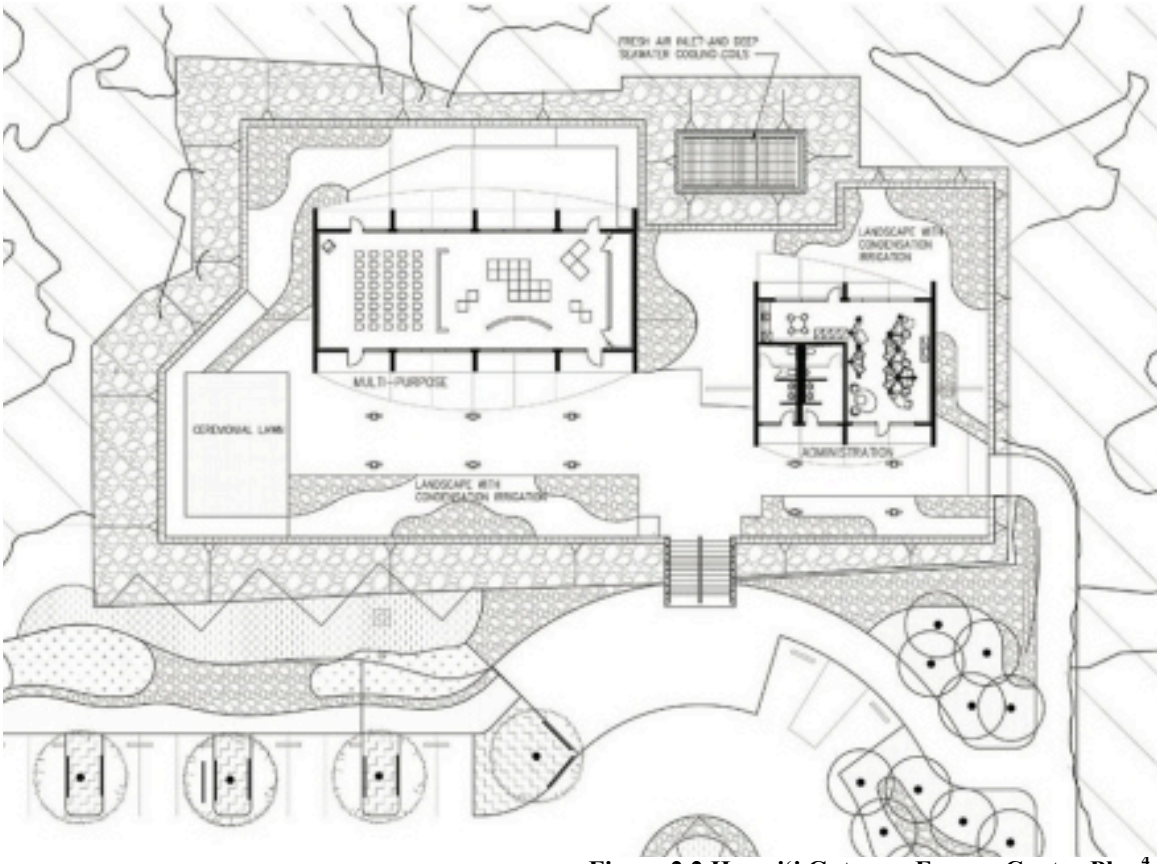

Figure 2.2 Hawai'i Gateway Energy Center Plan[4]

[3] David Franzen, "Gateway 8" (image), Available from: Friends of NELHA, http://abc.eznettools.net/D304001/X348271/EZ-PhotoAlbum/Gateway/index.html (accessed November 14, 2008).

BUILDING

The 3,600-square-foot visitors center consists of two buildings side by side- a conference and educational center and a smaller administrative space.[5] "The visitor complex houses administrative office space, restrooms, support areas, and a large multi-purpose space that will be used for displays, outreach, conferencing, and education."[6] In plan the two buildings are slightly staggered to each other organized by a grid creating bays set at equal intervals. Each bay is recognizable by the structural footings supporting the white steel truss system that envelope the two rectangular buildings. The larger building consists of four bays and provides the space for the multipurpose room. This building has an open plan with one partition, which does not touch the ceiling, separating the space for flexible use. The second building consists of just two bays and provides the administration space and restrooms.

The two buildings are built on a platform similar to the Hawaiian heiau making use of the abundant lava rock and creating an under-floor plenum essential for the innovative cooling strategy employed at the site. A Hawaiian heiau is literally translated as a "large place of worship" and is essentially a cleared area that is slightly elevated.[7] The platform elevates the building giving it better views, ventilation, and space for the passive ventilation system with little disruption to the site.

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[4] FCA, "HGEC Floor Plan," (image), Available from: AIA/COTE Top Ten Green Projects Online http://www.aiatopten.org/hpb/images.cfm?ProjectID=592, (accessed November 14, 2008).

[5] Tristan Roberts, "Hawai'i Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.

[6] AIA, "Hawai'i Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).

[7] Henry P. Judd, Mary Kawena Pukui and John F.G. Stokes, *Hawaiian Dictionary* (Honolulu, Hawai'i: Mutual Publishing, 1995).

The HGEC is oriented along the east-west axis to take advantage of the sun's energy for natural day lighting, energy production, and cooling through thermodynamics. This orientation also provides the best control for shading walls and windows and using the predominant wind patterns for ventilation. The building is designed to catch the eye of the passer by and it does just that with its strong architectural form elevated out on the barren lava field. Crucial to the projects success are its unique integration of design strategies to fulfill its program requirements.

The Hawai'i Gateway Energy Center began with six program requirements that focused the project towards the innovative sustainability it demonstrates today. The following six programmatic requirements are not the average requirements for a project; out of the six only one contains the usual stipulations of space that should be provided. Program requirements for the HGEC project include the following:[8]

1.) "As a 'Gateway,' the new facility shall reflect 21st century cutting-edge technology, strong aesthetic, environmental stewardship, and cultural sense of place."
2.) "Design principles of sustainable architecture shall be incorporated including consideration for zero-net energy by incorporating solar energy, advanced cooling technology, and other applicable technologies to meet the building's needs and immediate surrounding area energy demands."
3.) "The visitor center shall provide "Front of House" facilities such as an auditorium and public restrooms to facilitate education, outreach programs, and exhibitions."
4.) "Facility shall serve as a distributed energy facility and should emphasize the use of new and existing alternative and distributed energy concepts designed to minimize fossil fuel dependence."
5.) "The new facility shall make optimum use of deep seawater applications and recognize the limited availability of potable water."

[8] FCA, *Sustainable Architecture: Hawai'i Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).

6.) "The new facilities should incorporate concepts advanced in the LEED® Green Building Rating System wherever practicable."

Each of these program requirements was meet or exceeded through the innovative design of the HGEC. The request for a strong aesthetic is reflected in the dominating white steel trusses that point up into the sky. The seawater passive cooling system and air circulated by thermodynamics, precisely calculated through computer modeling, are some of the cutting-edge technologies used for the project. Environmentally speaking, HGEC employs numerous strategies including minimal site impact, environmentally conscious materials, and on site recycling programs. The buildings requirement to reflect a cultural sense of place is found in its strong relationship and respect to the land and sea.

The design used numerous principles of sustainable architecture together to achieve energy independence. Although, the consideration for zero-net energy by incorporating solar energy was not originally part of the design, photovoltaic panels were ultimately integrated. The design did not just minimize fossil fuel use but eliminated it by producing more energy than it needs. The HGEC uses photovoltaic panels to produce clean electricity use to pump deep seawater for cooling and fresh water production significantly reducing energy needed for cooling systems and water use. Thermal chimneys emerging from the building's roofs help power a passive cooling system that reduces energy needs, while the photovoltaic array supplies 110 percent of the buildings energy needs.[9]

Conveniently, NELHA was given access to cold seawater for cooling. As an added bonus the condensation created by the cold seawater on the cooling coils was collected and used for toilet flushing and irrigation. Wastewater is treated on site and injected back into the aquifer resulting in a healthy responsible loop of water use at the site.

[9] Tristan Roberts, "Hawaiʻi Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.

The design was guided and assessed by the categories put forth in the LEED Green Building Rating System. The HGEC achieved the highest possible rating (Platinum) by the LEED rating system but fortunately that did not limit the design. The architectural approach for the HGEC project was to design a building, which took advantage of all available sources of natural energy, thus requiring very little electricity from the local utility to operate. The architects also understood that sustainability is not just energy conservation but also addressing the various aspects associated with the design and its specific place. Besides energy conservation, sustainable design principles were used throughout the design of the facility to achieve water conservation, superior indoor environment for occupant health, and even to establish the buildings own unique visible identity as an energy 'Gateway.'[10]

The HGEC implements over twenty sustainable design strategies. Some of the strategies are simple strategies of building orientation while others are more complex innovations such as deep seawater cooling. The following list shows the broad range of sustainable design strategies used in conjunction throughout the building design resulting in its exemplary level of sustainability. It should be recognized that many of these strategies serve several purposes and often work together to achieve the overall sustainability of the building:

- Distributed Energy Facility
- Zero-Net Energy Facility
- Photovoltaic Energy Production
- Deep Seawater for Space Cooling
- Deep Seawater for Condensation Irrigation
- Deep Seawater for Fresh Water Production
- Septic System On-Site
- Greywater Use On-Site
- Native Landscaping
- Porous Paving Systems
- Day lighting Design

[10] FCA, *Sustainable Architecture: Hawai'i Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).

- Shading Design for Glazing
- Envelope Insulated Against Heat Gain
- Energy Efficient Building Orientation
- Energy Efficient Building Configuration
- Solar Chimney For Induced Ventilation
- 100% Outside Air Ventilation
- Recycled Materials
- Locally Produced Construction Materials
- Systems Commissioning

HGEC Sustainable Design Strategies[11]

Deep seawater for example, provides several sustainable aspects accounting for multiple sustainable strategies. The deep seawater cools interior space, produces fresh water, and irrigates landscaping. The building orientation, on the other hand, works with different sustainable strategies to contribute the overall building performance. Building orientation by itself is not significantly effective but combined with shading design, day lighting techniques, and ventilation strategies creates highly sustainable solutions to energy savings and indoor environmental quality. [12]

Many of the sustainable design strategies used for the HGEC are common practice for sustainable design. The Hawaiian environment inherently requires designs aiming for a notable level of sustainability to incorporate natural ventilation, shading, and day lighting strategies. Building orientation, material use, and site integration are common aspects of design to address in any sustainable project. The next section highlights some of the unique solutions to the challenge of sustainability developed for HGEC.

Without question the most unique and innovating strategy for sustainability at the HGEC is the passive ventilation and cooling system that uses cold deep seawater. Cold, deep seawater, pumped from 3,000 feet below sea level, passively cools the buildings. The seawater is 45°F when it arrives at the building for use. Once at the buildings the cold

[11] FCA, *Sustainable Architecture: Hawai'i Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).
[12] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).

seawater is distributed through cooling coils located in a dedicated air inlet structure, which is located between the two buildings. The cooled air then passes through a plenum beneath the buildings before being drawn through registers at the perimeter of the rooms above.[13] As the air within the buildings begins to heat up and rise it is exhausted through a thermal chimney at the highest level of the space. As hot air is exhausted cool air is drawn in through the fresh-air inlet where the deep seawater cooling coils are located and the cycle repeats.

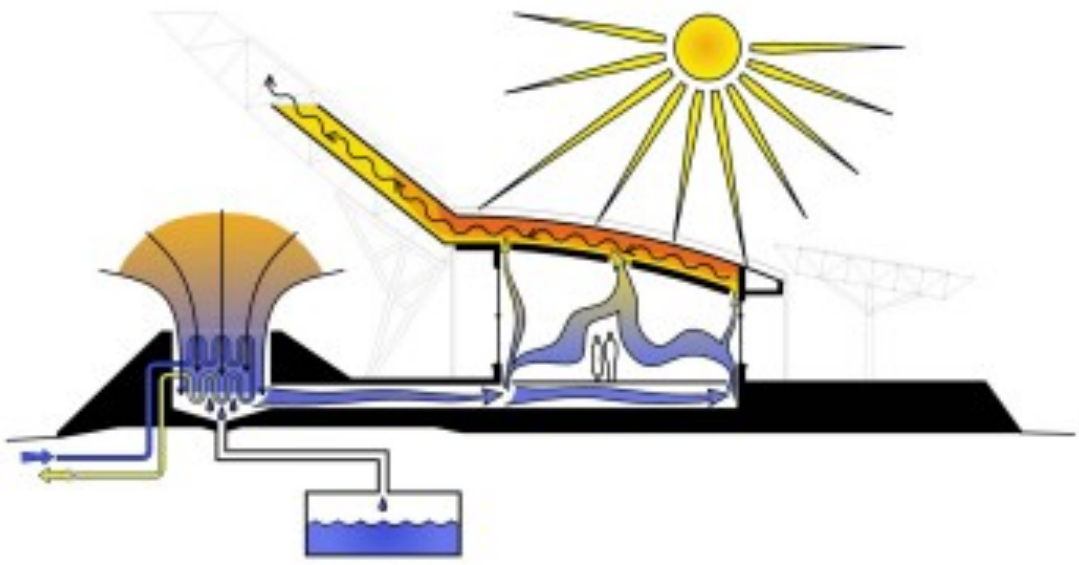

Figure 2.3 Diagram of Passive Cooling Strategy[14]

A thermal chimney is simply a building element that is designed to absorb and transfer heat to the air within it, and then allow that air to rise and exhaust. When this occurs, replacement air is drawn into openings lower in the chimney and a continuous thermo-siphon is created as long as the chimney is heated. The air being drawn into the thermal chimney creates negative pressure in the interior space causing air to move across the cooling coils and into the interior space to balance the pressure difference. As air moves

[13] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[14] FCA, "Diagram of Passive Cooling Strategy" (image), Available from: Ferraro Choi and Associates Homepage, http://www.ferrarochoi.com/sustainarch/NELHA/07-NELHA4_convection.html, (accessed November 14, 2008).

across the cooling coils it is dehumidified and cooled. At the HGEC project, the thermo-siphon is the "engine" that powers the passive ventilation system.[15]

A thermal chimney can come in many forms. Thermal chimneys are not just exhaust vents located near the ceiling of a building but thermal collectors as well. For the HGEC project, the thermal chimney is the curved copper roof and void space immediately beneath it. The copper roofing is designed as a thermal collector that heats up during direct sun exposure. This heat is transferred to the air immediately below the roof and exhausted out large vents protruding from the face of the building near the roof. Heating the air in the roof accelerates movement of air within the building. This cycle continues all day, providing fresh conditioned air to building occupants. The only energy consumed is for the circulating pump that delivers the deep seawater to the coils."[16]

Although the Hawaiian climate provides some of the best conditions for natural ventilation essentially demanding no air conditioning to be comfortable the HGEC project used this unique strategy to provide a higher level of comfort and indoor environmental air quality. This well thought out cooling strategy is environmentally beneficial and significantly reduces building operation costs.

Previously, there were misconceptions that sustainable buildings cost more to build and operate. In recent years this misconception has been substantially decreased. More often than not well-designed and constructed sustainable projects cost the same or less to build and substantially less to operate and maintain. The HGEC is no exception to savings in cost attributed directly to sustainable design strategies. With the exception of its photovoltaic array, the HGEC was financed by the U.S. Department of Energy, administered through the State of Hawaii Department of Business, Economic

[15] FCA, *Sustainable Architecture: Hawai'i Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).
[16] Ibid.

Development, and Tourism. The photovoltaic array was funded by the local electrical utility, Hawaiian Electric Light Company (HELCO), to promote public awareness of renewable energy systems.[17]

"Sustainable aspects of the design, with the exception of the photovoltaic array and energy distribution system, came at no premium, and payback was immediate."[18] Normally there are some startup costs incurred when implementing sustainable products and technologies and a payback time is determined. Payback refers to the time it will take for money saved on operational or maintenance costs to equal startup costs. In new construction this is usually a negligible issue.

The majority of operational costs are saved because of passive design strategies specifically the passive air conditioning system. No utility provided energy is required for ventilation and cooling because of thermodynamics. "The passive conditioning system was made possible by the availability of cold seawater, offered by the state to the renewable energy campus and adjoining aquaculture facilities for $0.32 per thousand gallons. A pump circulates the seawater as needed through the cooling coils, representing the only moving part and only electricity use in the space-conditioning system."[19] The other major energy costs associated with buildings is lighting. The HGEC uses day lighting combined with occupancy and photo sensors to reduce energy used for lighting.

Completing the project on its $3 million budget was a challenge, in part due to construction costs. "It's a contractor's market on the island," says architect Brooks,

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[17] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[18] AIA, "Hawai'i Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).
[19] Tristan Roberts, "Hawai'i Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.

noting the limited pool of contractors and the need to import building products.[20] Building materials available on an island located project are almost entirely imported driving up building costs beyond normal situations. For this reason resources, which include energy available locally, need to be incorporated to maintain project costs.

An important aspect of sustainability is creating a building that allows future occupants or uses of the space to be easily adapted so as to maintain a clean functional building. "HGEC is a small facility designed for ultimate flexibility. Predicted service life of the project is 50 years."[21] Including flexibility into the design ultimately increases the sustainability through an extended building life cycle.

The multipurpose space supports a variety of activities, including exhibits, conferences, outreach, education, seminars, and community meetings. Minimal partitions within the main structure support this multifunctional component. Raised-access flooring allows users to change the location of floor outlets and communications and data devices to suit various activities without major renovations.[22] New tenants would be able to reconfigure the interior layout and telecommunications system maintaining the buildings original integrity and passive cooling strategy. HGEC was designed to avoid a shortened life expectancy due to change of owner/user or renovations. Renovations can result in departures from the originally intended design because of the buildings inability to adapt. This sharply reduces the buildings life cycle and thus overall sustainability.

The Hawaiʻi Gateway Energy Center has been recognized locally, regionally, nationally,

[20] Tristan Roberts, "Hawaiʻi Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.
[21] USGBC, "LEED Case Study: Hawaiʻi Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[22] Ibid.

and internationally for its exemplary sustainable and green design strategies.[23] Awards include:

- 2005 AIA Honolulu AIA Award of Excellence for Sustainable Design
- 2006 Northwest & Pacific Region of the AIA Citation Award
- 2006 LEED® -NC v2 Platinum (New Construction) Certification by the United States Green Building Council (one of only 81 projects worldwide and the only project in the State of Hawaiʻi to have achieved such status);
- 2007 AIA National Committee on the Environment (COTE) Top Ten Green Projects

Speaking for the jury of the AIA/COTE Top 10 award, Traci Rose Rider said, "We were impressed by the way they blended active and passive technologies. It's really using all of earth's devices, then dramatizing that with this visible structure."[24] This recognition confirms the accomplishment of the program requirement to serve as a Gateway to sustainable practices in the Hawaiian Islands. These awards help to substantiate the potential of Hawaiʻi's abundant natural resources for production of clean energy.

The strategies for effectively using and producing energy through the design are an important aspect of emphasis for this case study. The sustainable design strategies implemented with the HGEC demonstrate a holistic approach to design and sustainability. Consequently it is also important to evaluate the consistencies between the sustainable, regional, and cultural design approaches. In order to achieve such a high assessment of sustainability HGEC had to take a broad approach to integrating various design strategies. This approach has similar characteristics found in the basic frameworks of Regionalism and culture.

[23] FCA, *Sustainable Architecture: Hawaiʻi Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).
[24] Tristan Roberts, "Hawaiʻi Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.

SUSTAINABLE DESIGN STRATEGIES

It is important to understand what sustainable strategies were used and how they were integrated together in the design. What made this project sustainable is the basic question being asked? This case study will help in understanding what the current sustainable design movement defines as sustainable. Energy efficiency is not the only aspect of sustainability. Sustainability involves a more holistic understanding of the site and region. The HGEC demonstrates a holistic understanding of the site and region, as it will be discussed. This study will specifically discuss the design process along with several major components addressed by the design that includes the site, energy, materials, indoor environmental quality, and LEED.

The design process reveals important decisions made during various stages of the project that contributed to the overall sustainability. True sustainability considers all the steps to producing a building from beginning to end. There were six stages during the HGEC project specifically contributing the sustainability: Pre-design, Design, Construction, Commissioning, Operations/Maintenance, Post-Occupancy.

During the pre-design phase the design team employed basic principles of sustainability and defined a degree of innovation. Originally the client was requesting proposals for the Hawai‘i Gateway Energy Center that provided a zero-net-energy facility. This facility was to incorporate green building strategies and demonstrate the unique resources and mission of the Natural Energy Laboratory of Hawaii Authority (NELHA). Through the process of pre-design the design team shifted from imagining a vague idea of sustainability to targeting state-of-the-art green design. The shift in approach also brought with it the goal of attaining a LEED Platinum certification.[25] “The client played

[25] USGBC, "LEED Case Study: Hawai‘i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).

an integral part in planning and imaging sessions and fully supported the team's decision to pursue unconventional passive design strategies."[26] The support of the client gave the design team freedom to innovate.

"During the pre-design phase, the client established beneficial partnerships with the local electric utility (Hawaii Electric Light Company) and land-use planning authority, both of whom took extraordinary interest in the long-term implications of the renewable energy, energy distribution, and water conservation technologies that HGEC would demonstrate."[27] This relationship resulted in the funding of the photovoltaic array that now provides 110 percent of the buildings energy needs. Involving the client from the beginning of the project in design considerations made obtaining the energy goals within budget possible.

"The unconventional design phase utilized a 'whole design process,' which differed from a 'linear design process' in that the architect and the consultants worked in concert from the beginning, evolving the design as a team."[28] This approach allowed the design to incorporate numerous sustainable strategies and integrate them for an efficient and effective design. The whole design process resulted in a high-tech innovative building. The innovative passive cooling system developed through the design process from a 64-foot-high thermal chimney to the angled trusses with multiple chimneys. This improved the function and enhanced the form of the buildings.

To ensure that the building would function passively as an effective thermal chimney, the engineer performed sophisticated computer modeling. Interestingly, "this established the building geometry and free area requirements along the ventilation pathway from the

[26] AIA, "Hawai'i Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).
[27] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[28] Ibid.

exterior inlets, below-floor plenum, ceiling plenum, and chimney outlets that were maintained throughout the design."[29] The buildings aesthetically powerful form is actually a product of maximizing its sustainable performance.

The project was delivered on a design-bid-build basis; because of this, contractor input did not occur until the construction phase. Having contractor input earlier in the process would have helped the project team tackle issues of constructability, waste management, and value engineering. "A waste management plan and indoor air quality management plan were implemented during construction. Additionally, site disruption and erosion were minimized."[30] The sustainability of construction is an important consideration because the construction process can result in a lot of waste and impact to the surrounding environment without responsible planning. LEED design guidelines include construction management as a component to assessing a buildings level of sustainability. The process of producing a sustainable building does not stop when construction is finished.

It is very important to commission a building either formally or by the design architect and major consultants. Commissioning is a step taken, usually by a third party, to make sure everything was constructed and functioning as designed. Commissioning is important for buildings designed with complicated mechanical, electrical, and pluming systems. The HGEC had very little to commission, as there were few mechanical systems, but there were refinements made to some of the lighting sensors and seawater pump.[31] These refinements reduced the total energy use of the buildings enough to officially qualify it as a zero energy structure.

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[29] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[30] Ibid.
[31] Ibid.

Commissioning should also include operation training and an evaluation of required maintenance. "Owner training was included in the commissioning process. The extensive use of passive design and low-maintenance materials should result in minimal maintenance requirements."[32] This aspect ensures that the building is used sustainably. A building by itself is not sustainable, the people using the building need to practice sustainability as well. When the users of a building understand how it is supposed to function, actions will be taken that work with the design intent instead of against it. For example, propping the doors open would disable the designed system of ventilation through the HGEC. This would be an unobvious mistake for anyone without knowledge of the design but through simple training the owner can take the needed action to ensure the building functions as designed.

Finally, it is important to evaluate a building after several months to a year after its opening to determine if things are properly functioning with for the design conditions. This is different than commissioning because commissioning typically evaluates the building at the initial use and does not factor in data over a period of time. For example, a year after construction further refinements were made to the seawater pump increasing the efficiency of the passive cooling system based on data collected.

Many sustainable strategies depend on the site and region. The design used site integration very well to increase sustainability. The HGEC demonstrates how integral site integration is to sustainability. The site of the HGEC is hot, humid, and barren. Mean average daytime temperature is 88 to 90 degrees Fahrenheit with average relative humidity at 85% to 90%. Rainfall is typically 10 to 15 inches per year, and annual insolation (sunlight energy) is the highest in the United States. The general terrain is a

[32] AIA, "Hawai'i Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).

pahoehoe lava field covered with fire grass and coastal shrubs.[33]

State law requires that all storm water be managed on site. To suffice this requirement and create a sustainable interaction with the site the HGEC minimized the building footprint and specified native coastal plants that require little water for landscaping. Additionally, pervious surfaces were used where possible and water from impervious surfaces is drained to the surrounding landscape.[34]

Water use was a significant aspect of the HGEC. "With an average annual rainfall of only 10 to 15 inches per year, harvesting precipitation is not viable."[35] The HGEC wisely collects the condensation from the cold seawater coiling coils in a holding tank below the buildings. Seawater is mixed with the collected condensation and used for deep-rooted plant irrigation and toilet flushing. The cold seawater is also used in a closed loop for irrigating shallow rooted plants through condensation formed on the pipes located just below the surface. The system acts like a drip irrigation system except water comes from the air not from the pipes.[36]

Sustainability also considers transportation to and from a site and in the instance of HGEC transportation on the site is also an important aspect. Although designated urban, the HGEC site is essentially isolated from the nearest urban population in Kailua, approximately seven miles to the south. The Big Island of Hawaiʻi has no public transportation system presenting a challenge in achieving LEED assessment points for alternative transportation. "Alternative transportation, including bicycles and electric

[33] FCA, *Sustainable Architecture: Hawaiʻi Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).
[34] AIA, "Hawaiʻi Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).
[35] USGBC, "LEED Case Study: Hawaiʻi Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[36] Tristan Roberts, "Hawaiʻi Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.

vehicles, is used within the 6.5 acre complex."[37] Support for more sustainable means of transportation is provided at the HGEC such as electric vehicle charging, storage area for bicycles, and public transportation access among other things.

Energy use was a large aspect influencing the HGEC design. The basis for energy conservation is architecture. "Conventional architecture often fails to take advantage of passive design strategies such as building orientation, shading, insulation, day lighting, and natural ventilation. As a result, most buildings end up consuming much more energy than necessary."[38] The HGEC was designed to operate on 20 percent of the energy needed by a conventionally designed building. Supplemented by the 20-kilowatt photovoltaic system the HGEC project resulted in achieving a net-zero energy building.

The passive cooling strategy is the key to energy savings in the design. Complemented by proper orientation, shading, and day lighting strategies the only energy use is for lighting a few hours each night and the deep seawater pump. The buildings are entirely lighted by day light during the daytime hours.

The HGEC is well insulated for the climate. Insulation is a necessary component for any air-conditioned or heated space. Altering the interior environment beyond the exterior air temperature is only effective if the building is well insulated. Even though the HGEC is passively cooled it is nevertheless a conditioned space that benefits from insulation. Energy conservation was once of many sustainable considerations in the HGEC design, environmentally responsible materials also added to the architecture.

Material choice is a significant aspect to sustainability and can realistically have the

[37] AIA, "Hawai'i Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).
[38] FCA, *Sustainable Architecture: Hawai'i Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).

biggest impact on the environment. In order to increase sustainability the first choice of materials to use is locally available sources. Unfortunately, the only local materials in Hawaii are lava rock, concrete, and concrete masonry units. Although these materials did not meet LEED credit criteria for local materials, the production plants are located within 25 miles of the project, significantly reducing the energy embedded in their transportation. These materials are also inherently durable and should require no regular maintenance.[39]

Many of the materials used in the HGEC were environmentally responsible products. Construction materials used in the HGEC with post-industrial or post-consumer recycled content include steel, thermoplastic olefin (TPO) roofing, copper roofing, thermal and acoustic insulation, gypsum board, carpet, resilient flooring, and countertops. The interior finishes emit low or no volatile organic compounds (VOCs). Carpet tile was used in lieu of glue-down carpet in the multipurpose space, and gravity-laid resilient flooring was used in the administrative areas. A glass, paper, plastic, and metal recycling program are followed in the building.[40]

The use of environmentally responsible materials has a great impact on the indoor environmental quality. The indoor environmental quality is a combination of materials and good building design. "The quality of the HGEC's indoor environment stems from excellent day lighting, views, ventilation, and thermal comfort. The HGEC's induced ventilation system provides a healthy 12 to 15 air changes per hour of 100% outside air, compared to the accepted industry standard of 6 air changes per hour (air that is re-circulated with only a modest percentage of outside air)."[41]

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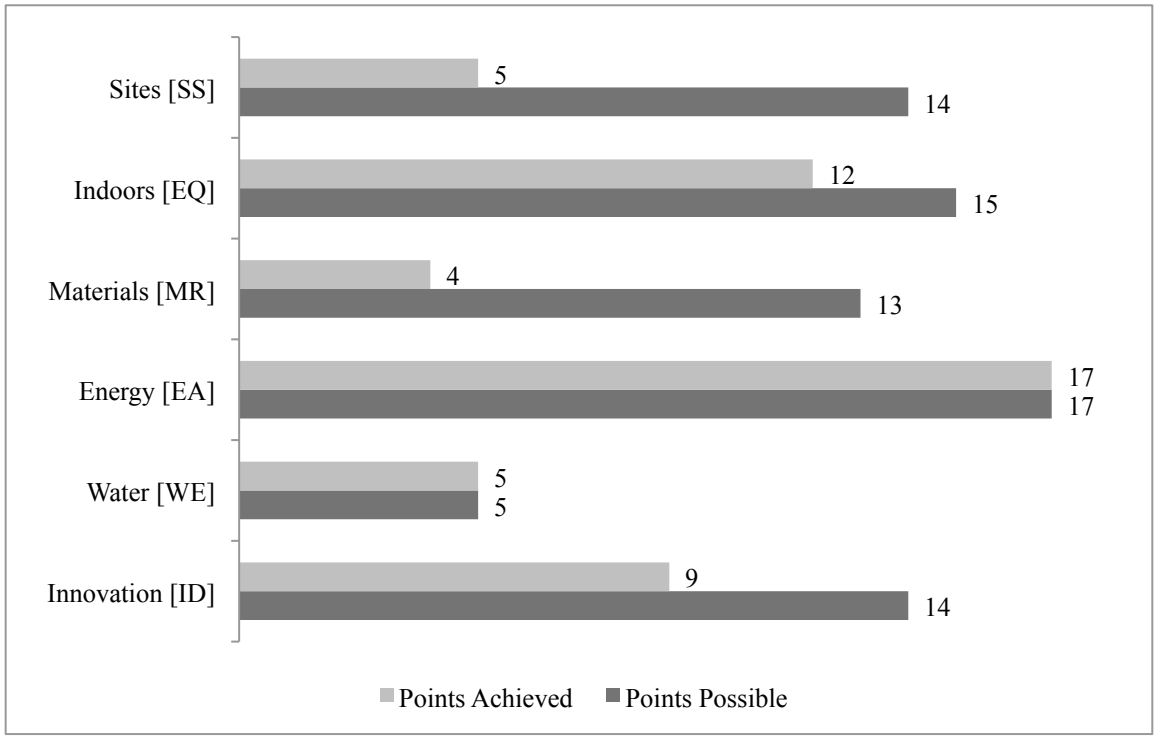
[39] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[40] Ibid.
[41] FCA, *Sustainable Architecture: Hawai'i Gateway Energy Center*, http://www.ferrarochoi.com (accessed November 13, 2008).

During daytime hours, day lighting provides all necessary lighting. All of the interior rooms offer substantial views of either the mountains or ocean. The north and south elevations are glass from floor to ceiling, and all of this glass is shaded from direct sun. "A translucent window treatment provides room darkening or privacy when desired."[42] Windows are fixed, as operable windows would interfere with the passive ventilation system. The ventilation design is based on stack ventilation. "Cross ventilation was considered undesirable, as it would have introduced noise, wind, and dust."[43]

The thermal chimney also helps provide a healthy indoor environment. The thermal chimney responds to interior and exterior heat gain, maintaining thermal comfort: when temperatures rise, the chimney effect increases and introduces more cool air to the building. The building maintains temperatures between 72°F and 76°F without mechanical controls. "Despite Hawai'i's hot, humid climate, "the building is pleasant, almost too cool for some people," says Rolston."[44]

Finally, the use of LEED made a significant impact on the level of sustainability achieved by the HGEC. The project did not originally have the goal of achieving a LEED certification yet as the design developed LEED ended up causing the design team push the sustainability envelope. The following chart shows points achieved by the HGEC in the six areas of assessment:

[42] AIA, "Hawai'i Gateway Energy Center," *AIA COTE Top Ten Green Projects 2007*, http://www.aiatopten.org (accessed November 13, 2008).
[43] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[44] Tristan Roberts, "Hawai'i Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.



The HGEC earned 52 points out of a possible 69 points and has an impressively low annual carbon footprint of just two pounds per square foot.[45] Attaining a LEED Platinum certification is not an easy certification to achieve, especially when there are few locally available materials and the passive ventilation system cannot count for energy saving. Remarkably the design team was able to earn the maximum amount of points for the energy category. "LEED calculation doesn't account for passive ventilation systems that work like mechanical systems," says architect Brooks. Since the building has no mechanical cooling system, LEED compared it with buildings with no cooling systems at all, which negated the energy savings achieved by its passive system. The project achieved the maximum number of energy points possible by leaning on its renewable energy generation. According to the energy analysis performed by Lincolne Scott, the

[45] Tristan Roberts, "Hawai'i Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.

building performs 54 percent better than an ASHRAE 1999-90.1 base case using a conventional cooling system.[46]

The LEED assessment system may have helped the design team organize the various aspects necessary to produce a sustainable design but fortunately it did not control the design outcome. The passive cooling system could have been abandoned if the project was focused only on attaining a high LEED certification.

ANALYSIS

The following analysis looks at the HGEC in terms of the client, firm/architect/design team, and design. The design is then evaluated on its regional qualities, sustainability, and integration of culture.

The Client for the HGEC was the Natural Energy Laboratory of Hawaiʻi Authority (NELHA). "Strong support and encouragement by the client as well as the whole-systems design process helped ensure the project's success. The general contractor was also engaged and proactive, which helped with the LEED submittal process."[47] A good client results in a good product. The client for HGEC was involved but only where he could support the project. Had the client decided to try and tell the design team what to do, instead of trusting they would design the building he was looking for, the project would be much different. The project budget and schedule would probably have been a disaster with over involvement from the client. Involving the right people at the right time helped the HGEC achieve its high level of sustainability. However, that does not mean everything went as smooth as it could have gone. The contractor for example was

[46] Tristan Roberts, "Hawaiʻi Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.
[47] USGBC, "LEED Case Study: Hawaiʻi Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).

not able to be involved earlier in the project, which would have allowed for a better communication of the design and overall goal of project sustainability.

The contractor plays a significant role in the sustainability of a project through taking the proper actions to proceed with construction in a manner that is environmentally responsible. Having the contractor involved earlier in the project allows the design team to increase the sustainability of construction. There is a lot of waste that occurs during construction that can otherwise be avoided by reusing forming materials for concrete or optimizing material quantities to avoid excess. Likewise, negative impacts to the site often occur during construction negating the fact that the structure being built is sustainable. The design team did recognize that there was room for improvement in this category.

Overall, the client can be credited with the zero-net energy achievement of the building because of his work with the electrical company to provide the photovoltaic array. Similarly, the deep seawater made available was a result of client participation and foresight in the project. It must be stressed that the client appeared to know his bounds giving the design team the freedom to explore an innovative solution. Trust between the client and the design proved to be a highly beneficial aspect of the project.

The architecture firm responsible for the project was Ferraro Choi and Associates (FCA). The NELHA wanted a design expressing novelty and they went to the right firm. FCA is a firm dedicated in producing sustainable buildings; most clients seek them out for their experience in sustainable design. Design architect Bill Brooks is a man willing to test the boundaries. He is very versatile in skills with the ability to talk business and numbers one moment and artistic exploration the next. This flexibility appears to be very helpful in the architectural field especially with sustainability. FCA has a crucial relationship with the equally innovative and sustainably focused engineering consultants Lincoln

Scott. Lincoln Scott is a huge player in facilitating the ideas FCA develops. Without this relationship it is hard to see FCA able to produce functional designs with the level of sustainability they have been achieving. It is one thing to have an idea about something and quite another to bring it to reality.

There was subtle but ever so important piece of the design vision that made a contributing difference to the result of a sustainable building and a Platinum LEED certified zero-net energy sustainable building. The piece was the architects' recognition that the LEED assessment system should not limit or entirely drive the design. LEED is a broad assessment system designed to evaluate a broad range of projects. One of the major weaknesses of the LEED assessment system is failure to adequately included innovative design solutions into the point systems. Brooks did not let this prevent him from pursuing the simple but elegantly design passive cooling system.

The design team also showed a willingness to invest in the project even after it was completed. A year after the buildings had opened the design team made adjustments in the seawater pump raising the efficiency resulting in increased sustainability. This would not have happened if the design team had moved on and forgotten the project once it was finished. Personal interest and a dedication to provide the client with the highest level of sustainability possible without stopping because of a completion date proved key to the projects success.

An area of improvement is the unforeseen deflection of wind off the solar panels into the thermal chimneys. "Experience with the facility has shown that in a south wind, which is most common, the thermal chimneys work well. The air exchange rate is too low in a north wind, however. The photovoltaic panels, not originally present in computer modeling, deflect the north wind into the chimneys, counteracting their draw. The

designers are working on modifications to resolve this problem."[48] This problem in the scope of the entire project is minor inefficiency that can ultimately be solved. The test of time and varying circumstances will inevitably challenge the true success of the project but for now the HGEC design is an exemplary model of sustainability in the Hawaiian Islands.

The design of the HGEC was done well leaving little room for suggestions of improvement. Aesthetically the design of the HGEC was to catch the eye of the passerby. Will Rolston, the Hawaiʻi Gateway manager, reports it's working. "Visitors come up the stairs with their eyes wide open," says Rolston, noting that, according to a visitor survey, 70 percent of visitors, many of them passing the building while traveling to or from the island's main airport, come because they notice the unique structure. "If they are people with energy backgrounds, you can tell it puts them in a place where they think about what is possible."[49] The design also stands as a model for the level of sustainability that can be achieved in the context of the Hawaiian region. As the saying goes, actions speak louder than words and HGEC is a strong action demonstrating the sustainable potential of the natural resources waiting to be used.

CONTINUITY – REGIONALISM, SUSTAINABILITY, CULTURAL INTEGRATION

It is being argued through this research that Regionalism, Sustainability, and Culture all reflect similar qualities and characteristics. This case study revealed that a project approached almost entirely from a sustainable perspective displays good principles of Regionalism and Cultural appropriateness. Regionalism primarily exudes design principles that address contexts prevalent at a given site for a specific region and local

[48] Tristan Roberts, "Hawaiʻi Gateway Energy Center: Gateway to Sustainability," *GreenSource: The Magazine of Sustainable Design*, July 2007: 66-71.
[49] Ibid.

culture. Since Regionalism and Sustainability have redundancies in their focuses it will be better to address the areas of difference.

Sustainable design recognizes that a building is much more sustainable if it responds to the environment and uses materials from the region in its design. The HGEC as it has been discussed did just that in its strong integration with the environment, surrounding landscape, and use of both local material and energy resources. Provided the use and purpose of the building, HGEC is a good example of Regionalist architecture.

Regionalism does not mean a building should reflect indigenous forms, aesthetics, building, materials, and construction. Regionalism is a contemporary interpretation of the contexts of a region, which includes the culture, and its representation in architecture. Regionalism is aimed at creating architecture of place that is appropriate and identified with the region it is built. The HGEC's unique passive cooling system and landscape are all highly identifiable with the tropical climate of Hawaiʻi. The cooling system reflects the abundant ocean resource in conjunction with the immense solar energy in the region. The HGEC is truly a regional design it just happens to include an intense focus on energy and environmentally conscious materials.

The sustainability of the project is clear and effective. The HGEC does not only reduce its use and demand of natural resources such as water and the fossil fuels typically used to produce electricity but it exports them. The HGEC is not just an efficient design but also an effective one because it produces more resources than it consumes. Multiple aspects of the project take advantage of what would normally be wasted energy and use it to satisfy other needs significantly increasing the sustainability. The best example of this is the collection of condensation from the cooling coils to flush toilets and irrigate the surrounding landscape. HGEC demonstrated the effectiveness of integrating numerous sustainable design strategies to achieve unprecedented levels of sustainability.

The integration of sustainable concepts in the HGEC is a big lesson to be learned. Some concepts are very simple such as shading the windows and walls from direct sun exposure while others are more complex such as the passive cooling strategy. The important thing to understand is that over twenty sustainable design strategies were used at the HGEC to achieve the results it did. Sustainability is not just one aspect.

Sustainability involves a holistic approach that addresses every aspect of the building including the site and surrounding community. In this regard Sustainability is very similar to the principles of Regionalism. Regionalism stresses the consideration of all the contexts of a site and Sustainability requires this broad consideration to be truly successful. An aspect of sustainability that is usually overlooked is the cultural aspect.

Cultural integration was not necessarily a focus for the HGEC but regardless it did address cultural concerns of the region. For a project designed foremost to be sustainable it is impressive how appropriately cultural values of the region are integrated into the buildings. A culturally appropriate design is not some mock up image of an indigenous structure but the reflection of the cultures values. The cultural values in Hawaiʻi can easily be confused because of the wide range of cultures coming together from various corners of the Pacific region. Most cultures would agree that responsible use of the natural resources is imperative. The HGEC is a good representation of the mixed cultural environment in the Hawaiian Islands and stands as a clear symbol for values of the region.

"During the pre-design phase, the client established beneficial partnerships with the local electric utility (Hawaii Electric Light Company) and land-use planning authority, both of whom took extraordinary interest in the long-term implications of the renewable energy, energy distribution, and water conservation technologies that HGEC would

demonstrate."[50] A relationship with the surrounding community helped achieve the project goal. Without the communication and involvement of other members of the community the sustainability may have been decreased.

Figure 2.4 Hawaii Gateway Energy Center Sunset[51]

[50] USGBC, "LEED Case Study: Hawai'i Gateway Energy Center," *U.S. Green Building Council*, http://leedcasestudies.usgbc.org (accessed November 13, 2008).
[51] David Franzen, "Gateway 21" (image), Available from: Friends of NELHA, http://abc.eznettools.net/D304001/X348271/EZ-PhotoAlbum/Gateway/index.html (accessed November 14, 2008).

CHAPTER 3

DEFINING CULTURE

> *"Culture should be regarded as the set of distinctive spiritual, material, intellectual and emotional features of society or a social group, and that it encompasses, in addition to art and literature, lifestyles, ways of living together, value systems, traditions and beliefs."*
>
> *(UNESCO, 2002)*

An individual's relationship to culture or cultural identity is personal. It has to be because culture defines part of who we are as individuals. Culture evolves from shared lifeways of individuals who form a relationship as a community and pass it on collectively from generation to generation. The purpose of this research is to create and argue that, combining the qualities of regionalism, sustainability and culture, is an effective design method. Culture plays a vital role in understanding a region and inspiring architecture.

Culture is the act of living. Every aspect of human existence creates the characteristics that define a culture such as family, children, ancestry, eating, feeding, hunting, gathering, cultivating, building, travel and exploration. All the various studies found in academia such as psychology, philosophy, biology, history, business, economics, art, music, and sports focus on aspects that define a culture. Uniqueness is the major focus in the study of culture. In western thinking, culture commonly means "civilization" or

"refinement of the mind" and usually refers to education, art, and literature.[1] More comprehensive definitions include the day-to-day patterns of life along with the activities that refine the mind.

Culture guides one's thinking, doing, and being and becomes patterned expressions passed down by generations to create identity.[2] Patterns are the most direct means of recognizing, comparing, and distinguishing uniqueness between cultures. As people spend time together they begin to develop similar patterns of thoughts and actions. These patterns then become recognized as customs and practices unique to that group of people referred to as their culture.

No individual can have a neutral vantage point to culture. Each person carries with them patterns of thinking, feeling, and acting that were learned throughout their lifetime from the cultures they have experienced.[3] Every culture is an idea and reaction to the universal realities of life. Many aspects of human existence such as feelings, eating, and sleeping are universal to all people but how they are practiced are distinct features of a culture.

Culture is viewed from the perspective of each individual's worldview. The definitions of culture provided by various recognized cultural and social anthropologists such as Clyde Kluckhon, Clifford Geertz, Edward T. Hall, Robert Kohls, and Geert H. Hofstede helped isolate some of the key components to defining culture. Using these key components a definition of culture was developed by this research in order to clarify the relationship of cultural distinctions to architecture. The following definition of culture addresses a community's unique response to the broad spectrum of categories and the

[1] Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (New York, New York: McGraw-Hill, 2005), 3.
[2] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 3.
[3] Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (New York, New York: McGraw-Hill, 2005), 2-6.

connection it has to architecture: Culture is the unique customs and practices of a community holding similar beliefs, values, and traditions in response to space, time, environment, communication, biological differences, and social organization that become meanings expressed through art, architecture, symbols, spirituality, and ways of living.

The term culture implies both a dynamic and ever-changing process as well as one with elements that change more slowly.[4] Beliefs, values and traditions change slowly over an extended period of time. Other components of culture such as art, architecture, and clothing are in a constant state of evolution. In order to better understand culture this research will discuss first, what cultural values are; second, how cultural values are formed within a community; and third, a framework with six broad categories to help identify characteristics and spatial results of culture that are useful in the design process.

3.1 BELIEFS, VALUES AND TRADITIONS

The beliefs, values and traditions of a culture permeate every aspect of human life. No one gets the opportunity of a "clean slate" when it comes to deciding his/her personal beliefs. Personal beliefs, one's worldview, are what one believes regarding things such as the origin of the cosmos, why we exist, and what happens when we die. Answering these tough questions is impossible for an individual without drawing on the experiences of the culture around them. The values of the culture a person is raised in is far more influential and defining than biological aspects such as race and gender. "Culture is learned, not innate."[5]

[4] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 3.
[5] Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (New York, New York: McGraw-Hill, 2005), 4.

Beliefs are a core foundation to culture. Religion, as it will later be discussed as part of social organization, is a symbol for communicating cultural beliefs. Beliefs are more specifically a matter of what one believes to be true in the relationship of humans to the divine. This relationship to the divine is expressed most vividly through architecture and the built environment.

For example, a Christian would believe that Jesus Christ is the creator of all things. "For by Him [Christ] all things were created, both in the heavens and on earth, visible and invisible, whether thrones or dominions or rulers or authorities—all things have been created through Him and for Him."[6] This belief causes the Christian to value creation (the world and all that is in it) as God's work. These values can become represented in various ways. The magnificence of a cathedral built with precious materials and aspiring to reach the heavens is understood based on the belief that all things have been created through Him and for Him. This is an example of how beliefs shared by a community of individuals can create an architecture influenced by those beliefs.

Cultural beliefs also define space as private, public, sacred or secular based on the importance of assigned space and/or objects within the space. Private space is typically something such as one's home and areas within that home such as a bedroom and bathroom. Public space is usually defined with obvious indications that it is for public access. Sacred and secular space can either be private or public. A sacred space will have limited access with specific rules as to who may access the space and is directly related to the beliefs and values of a culture or even individual. Secular space on the other hand is space with little or no prescribed importance. Saint Peters Cathedral in Rome provides an example of private, public, sacred or secular space. The space outside of Saint Peters Cathedral site is public secular space, the main courtyard is public sacred

[6] Lockman Foundation, *New American Standard Bible*, NASB Text Edition (Anaheim, California: Foundation Publications, 1997), Colossians 1:16.

space and the interior is private sacred space. Each different space is defined by the beliefs of the culture.

Values ultimately become an action that communicates the beliefs of an individual or culture. Values become the physical manifestation, by expressions such as architecture, of beliefs by a cultures response to things such as environment, space, and social organization. Values are the inspiration for design and the ordering of space.

Values give meaning to life. These values are sources of inspiration for creativity through which societies recognize themselves. The cultural heritage of many people is strongly associated with a place, locality, or natural landscape.[7] Significant events, persons, artistic expressions, and history associated with a site further shape and give meaning to a culture's identity.[8] Architecture plays a significant role in embodying and representing cultural values relative to place. The values of a culture need to be the source of inspiration for architecture.

In the United States there are guidelines such as the National Register Criteria concerning what is important for determining what architecture constitutes preserving. Each of these guidelines defines cultural aspects of architecture. Charles A. Birnbaum of the National Park Service, chief landscape division, defines a cultural landscape as, "a geographic area including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values."[9] A cultural landscape is all the aspects of defined space including vegetation and topography. Natural features such as mountains, fields, oceans, lakes,

[7] ICOMOS, "The ICOMOS Charter for The Interpretation and Presentation of Cultural Heritage Sites" (Quebec, 2008), 8, 2.
[8] Patricia L. Parker and Thomas F. King, "Guidelines for evaluation and documenting traditional cultural properties," *National Register Bulletin* (Depatment of The Interior National Park Service), no. 38 (1998): 28, 12-14.
[9] Charles A. Birnbaum, "Protecting Cultural Landscapes: Planning, Treatment and Management of Historic Landscapes," *Preservation Briefs* (U.S. Department of The Interior National Park Service), no. 36 (1994).

waterfalls, streams, trees, and wildlife can be important sources of identity to a people. Paths, roads, buildings, and monuments are just as much a part of the cultural landscape as the natural features. The significance of a cultural landscape is rooted in a people's beliefs, customs, and practices.

Many of the beliefs and values a culture possesses become manifested in their traditions. Tradition is repetition over generations and can act to transfer cultural values to a building. Traditions impart meaning to a building because a building cannot have any meaning unless the users can associate it with their cultural values.

Like traditions, rituals reinforce the values and beliefs held by a community. "Rituals are collective activities, technically superfluous to reaching desired ends, but which within a culture are considered as socially essential."[10] Rituals and ceremonies help transfer the beliefs and values held by a people on to places or objects such as buildings that would not otherwise have special meaning. Rituals can be performed for site selection, blessing the construction, completion, or use of a building, all of which give meaning and identity. Architecture, along with providing protected space for rituals also reinforces the ritual itself with a strong symbol associated to place.

Knowledge is included in this section because it has a significant impact on a culture's characteristics depending on how it is viewed by the culture. Hawaiian culture, for example, values knowledge of naturalistic things such as past history, family lineages, and environmental relationships.[11] A deep understanding and knowledge of the environment such as winds, rains, seasonal changes, and celestial patterns get reflected in a culture's architecture. The orientation, materials, structure, function, and aesthetic of a

[10] Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (New York, New York: McGraw-Hill, 2005), 8.
[11] Davianna McGregor, *Nā Kuaʻāina: Living Hawaiian Culture* (Honolulu, Hawaiʻi: University of Hawaiʻi Press, 2007), 1-48.

building can be the result of a culture's knowledge of the environment reflected in architecture. For example, a culture's knowledge of rain for a site/region would be reflected in a buildings roof slope and knowledge of wind patterns would be reflected building orientation and wall openings.

How knowledge gets communicated is a trait that can be very specific to a culture. Knowledge can be communicated through dance, storytelling, music, poems, art, architecture, and of course writing. Some knowledge can only be learned through experience. This is a sort of unifying characteristic in human culture globally. Regardless of how a culture chooses to communicate knowledge, knowledge gained through experience is present in every culture. Knowledge impacts architecture just like any other cultural value. Indigenous experience and knowledge can have a very positive influence on architecture.

Indigenous people have experienced knowledge of the seasons and climate along with a good understanding of the resources available locally. Traditional knowledge has the potential to impact architecture the most in sustainable practices. "In terms of environmental assessment, indigenous people that rely on local resources for their livelihood are often best suited to determine costs and benefits."[12] Each culture uses knowledge in different ways. For example, the early Polynesian culture used their extensive knowledge of nature for the exploration and settlement of the Pacific region.

The Polynesian Settlement of the vast expanse of the Pacific islands is an outstanding representation of accumulated knowledge of a society. The navigational science and canoe technology of the early Polynesians represents a highly developed and refined knowledge of maritime skills and an extraordinary level of social organization. The voyaging canoes of the Hawaiians are one such example of an indigenous culture's

[12] Indigenous Peoples' Restoration Network, "TEK & Western Science," *Society for Ecological Restoration International* , http://www.ser.org/iprn/westernscience.asp (accessed September 17, 2008).

scientific and technological knowledge. The design itself represents the accumulated knowledge of the society in every component that makes up the whole. The canoe represents the technological levels of the society out of which it was created. Highly skilled artisans created each component of the canoe from the hull to the lashings and sails. This represents extraordinary level of social collaboration used to construct, supply, and launch the voyaging canoes. The Polynesians used their deep knowledge of the environment to develop non-instrument navigational techniques termed wayfinding. Wayfinding uses the sun, moon, stars, and other indicators of nature such as swells and animal life to determine direction on open water.[13]

3.2 FORMING CULTURAL VALUES

"Culture is shaped by values, beliefs, norms, and practices that are shared by members of the same cultural group."[14] Things that influence groups of people form cultural values. For instance, the surrounding environment would affect all the people living in a particular region. The surrounding society, families, and individuals influence one's experiences forming personal values. Larger influencing forces form cultural values. Cultural values are formed when the personal values of many combine under the influences of large contextual forces.

The environment has potentially the most noticeable affect on a culture and consequently the architecture as well. "Culture represents a unique way of perceiving, and evaluating the external environment and as such provides a blueprint for determining values, beliefs, and practices."[15] Environment can affect cultural values by the incredible influence it has

[13] Will Kyselka, "The Star Compass," in *The Wayfinding Art: Ocean Voyaging in Ancient Polynesia*, ed. Cary Sneider and Will Kyselka, 23-24 (Berkeley, California: Regents of The University of California, 1986), 23-24.
[14] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 3.
[15] Ibid.

on how people live and experience their day-to-day lives. A Culture that lives in a harsh environment like a desert where basic living needs such as food, shelter, and water are precious resources will adapt values that stress great importance on such things. A culture that lives in a life-abundant environment like a jungle will adapt a different value to their resources due to its abundance.[16] Whether a resource is scarce or abundant it is still important. However, it may develop a different use or value based on its availability.

Recently the International Council on Monuments and Sites (ICOMOS) wrote a new declaration on the importance of preserving the spirit of place. The spirit of place is made up of tangible as well as intangible elements, which all significantly contribute to the sense of identity of a given area. The spirit of place especially focuses on the intangible elements such as memories, narratives, festivals, commemorations, rituals, traditional knowledge, values, textures, colors, smells, and so forth. The intangible elements of place are continuously changing. It is important to understand that the people transmit the spirit of place. This is usually done through narratives, rituals, and performances of songs and dance. To understand and experience the spirit of place specifically the intangible aspect one must interact with the people.[17] The transfer of the spirit of place is important architecturally because it allows new buildings to hold and represent a people's sense of identity. A building that embodies the spirit of place is given meaning and importance as a representation of the cultural values held by the surrounding community.

Architecture that reflects a clear sense of place should address the regional context through design. Cultural values are a strong context to a site. The indigenous identity of a people interpreted through buildings such as museums and cultural centers, plays an important role in outsiders perception of that indigenous people group. Both the

[16] Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (New York, New York: McGraw-Hill, 2005), 16.
[17] ICOMOS, "Quebec Declaration on The Preservation of The Spirit of Place" (Quebec, 2008), 4.

architecture and the way in which artifacts are housed within the museums affect the interpretation of a people's indigenous identity. "Indigenous identity is not separate from external forces and influences, and architecture is one of these influences."[18] Indigenous identity is typically strongly related to the relationship of ancestors to place.

Custodianship, or taking care of a land, is an important practice that results in indigenous identity to a place. Indigenous people are custodians of the land they live on, because this identity is associated with the land. "The process of place recognition necessitates that its meanings must be socially constructed through a continuity of practices over time."[19] The indigenous identity cannot be fully recognized until the culture has occupied that space and can begin to associate meaning to it through use.

Stories and folklore passed down through generations in indigenous cultures commonly relate to places and objects of nature and the ancestors of the people, whether real or imagined. The bond formed with a place over time becomes an important part of indigenous identity. Understanding the indigenous identity to a place is developed through learning their beliefs often communicated through verbal and graphic stories, songs and dances.[20] To the indigenous Hawaiian culture for example, the Island of Kahoʻolawe is the embodiment or body form of the Native Hawaiian god of the ocean Kanaloa and as such "links the island to its role as a traditional center in way-finding between Hawaiʻi and Tahiti."[21] Without knowledge of this information the island can be viewed simply as another landmass to non-indigenous people.

Architecture must undergo place transfer in order for indigenous cultures to identify with a building. The idea of "place transfer" developed by Paul Memmott, is one way new

[18] Shaneen Fantin, "Aboriginal Identities in Architecture," *Architecture Australia*, Sept/Oct 2003: 84-87.
[19] Ibid.
[20] Ibid.
[21] Davianna McGregor, *Nā Kuaʻāina: Living Hawaiian Culture* (Honolulu, Hawaiʻi: University of Hawaiʻi Press, 2007), 253.

architecture in indigenous settings can gain place recognition. Ceremonies such as dancing and playing music are strong ways of giving meaning to a place. Other means of place transfer to give new places meaning and significance are daily activities such as meeting, talking, sitting, learning, playing, working, painting and cooking.

Understanding culture can lead to more informed appropriate architecture that indigenous people groups can associate identity of place and meaning. Architecture and culture are influenced by one another. An architect's cultural values are often different than the community he is designing a project for. "Architects and designers need to have an understanding of the complexities involved in the use of abstracted metaphors and encryptions from Aboriginal culture into architecture, which is mostly derived from the architects own world view."[22]

Social changes have an effect on a culture's values. Social changes are a shift in personal values that begin to reveal themselves in the greater cultural context. For example, the navigation art of wayfinding and ocean voyaging was abandoned by the indigenous Hawaiian culture due to changes in social structure and ways of living. This practice in the last few decades is now being revived because of a social change that is looking back to the value of this navigational art. Social changes can also be seen in more mundane tasks of life such as clothing styles, greetings, or language variations.

As cultures interact knowledge is shared and differences experienced. Cultures with similar belief systems are drawn together and repelled by those with alternate belief systems. The interaction of culture can be an explosive situation. For this reason avenues for healthy cultural interaction that allow the sharing of values and knowledge are important. Architecture can serve as a healthy avenue by being a place or symbol for healthy cultural interaction. The values of a culture can be shared and understood more

[22] Shaneen Fantin, "Aboriginal Identities in Architecture," *Architecture Australia*, Sept/Oct 2003: 84-87.

clearly when an individual can see, feel, hear, and experience architectural space expressing the culture's values. Architecture allows people to experience other cultures in a non-invasive form of communication. This is why experiencing the local architecture is a significant part of most people's travels and why architecture that appropriately represents the culture and place is so important. It is a powerful tool for communicating cultural values that can give people sense of identity. As Geert Hofstede put it, "a sense of identity provides the feeling of security from which one can encounter other cultures with an open mind." Regionally appropriate architecture can result in the healthy development of civilizations.

3.3 FRAMEWORK – SIX CATEGORIES OF CULTURE

The following six categories are derived from Giger and Davidhizars framework for understanding culture: Communication, Space, Time, Social Organization, Environment, and Biology. These categories provide a holistic framework for understanding cultural values.[23] These broad categories identify prominent aspects that can define a culture and help identify unique characteristics. It should be noted that each culture has unique characteristics that go beyond the general framework discussed here. This basic framework provides a starting point for understanding different cultures. While all of these categories may inform architecture, which ones directly influence architecture depends on the context. It is important to have a holistic framework to avoid neglecting a unique aspect of a culture. This allows one to identify the unique qualities that create cultural identity for the specific user. This research identifies specific cultural characteristics as applied to Hawai‘i and more specifically Kaho‘olawe.

COMMUNICATION

"Communication is a continuous process by which one person may affect another

[23] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 8-15.

through written or oral language, gestures, facial expressions, body language, space, or other symbols."[24] Communication is manifested in numerous forms within a culture, architecture being one of them. As a type of communication architecture conveys cultural values through forms and the various qualities of a building such as its acoustic and sensory perception. Light, wind, shadows, rain, acoustics, views, and materiality can be manipulated by architecture to communicate a desired feeling or understanding of space. For example, western architecture primarily communicates hierarchy through size, materials, color, and decorative features among other things. Traditional Hawaiian society, which used similar natural materials for construction, primarily communicates hierarchy through size such as height of the ridgepole, distance between structures, separation of chief's houses from other houses, and symbols such as pulo'ulo'u or tapa ball placed on top of a stick.

Certainly, there are multiple ways to communicate the same thing but cultures will develop patterns of communication that can be identified and differentiated. For example, in traditional Hawaiian culture people would greet each other in a way that required close physical contact but in western culture that closeness is only reserved for friends and family.[25] In both cultures it is still a greeting but the actions mean different things. Differences between culture and communication are often referred to as "the language barrier" even though the differences being referred to may have very little to do with oral language but rather the numerous other forms of communication. Differences in languages and other cultural aspects create boundaries and boarders that define space. This is one aspect of how cultural values become represented in spatial relationships. Architecture can be a tool for minimizing the language barrier by communicating values and concepts through various forms using several of the human senses such as sight,

[24] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004). 21.
[25] George S. Kanahele, *Ku Kanaka, Stand Tall: A Search for Hawaiian Values* (Honolulu, Hawai'i: University of Hawai'i Press, 1986), 196.

sound, and touch.

Simply observing a culture's communication patterns will help in understanding various social aspects particularly family relationships. Culture and communication are inseparable; all forms of communication include cultural content.[26] Architecture is a form of communication and full of cultural content. Architecture communicates attributes of the surrounding environment and the relationship the local culture has with the region. An open building with light structural elements communicates an inviting climate that the user has chosen to be exposed and connected to. Architecture also communicates aspects of a community's social organization through the different layouts and uses of space.

SPACE

Space, for the purposes of this study can be understood on a scale that ranges from geographical space being the largest to personal space being the smallest in terms of culture, architecture, and identity. Space, culturally speaking, refers to "bodily space" and things that define visible or invisible boundaries surrounding a person's body; known as "proxemics."[27] A culture's organization of space can be an indicator of their values. The organization of space is a significant physical characteristic of a culture.

The physical manifestation of a culture and its values is best communicated through the organization and use of space. "Built structures overtly express cultural values."[28] Architecture organizes and conceptualizes space making it an opportunity to understand or influence a culture's identity. Architecture is built to accommodate human activity.

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[26] Craig Storti and Laurette Bennhold-Samaan, *Culture Matters: The Peace Corps Cross-Cultural Workbook* (Washington DC: Peace Corps Information Collection and Exchange, 1997), 75.
[27] George S. Kanahele, *Ku Kanaka, Stand Tall: A Search for Hawaiian Values* (Honolulu, Hawai'i: University of Hawai'i Press, 1986), 194.
[28] Dora P. Crouch and June G. Johnso, *Traditions in Architecture: Africa, America, Asia, and Oceania* (Oxford, New York: Oxford University Press, 2001), 285.

The ordering of space, architecturally, has the ability to affect human actions, provoke response, and communicate meaning.[29]

Cultures often organize space into two main categories, tactile space and visual space. Tactile space is space that can either be touched or entered. Touch is a very influential stimuli and the ability to experience something through touch or be prohibited from touching is a cultural determination. Visual space is obviously the space that can be experienced through visual receptors and is strongly linked with the tactile space.[30] For example, one does not usually buy a house without both experiencing the visual and tactile space such as touching the walls and finishes of rooms and looking out through windows at the view. The space of a prison is far different than the space of a cathedral although both can be made of stone. This is because the culture weaved its values into the order and experience of the space.

Indigenous cultures specifically understand architectural space in values associated with the landscape. The architecture is not meant to remove one from the landscape but rather connect one and reinforce the value of the land. The space can communicate different experiences through use of light, materials, environment, and organization. The use of local materials in the defining of space makes a direct connection to the land. A culture's use and organization of space can help one understand the values of a people. A culture's response to time, similar to space, can be reflected in architecture.

TIME

There are two things to discuss concerning time and culture. There is culture's relation to time literally such as a schedule and hours in a day, and the culture's holistic relation to

[29] Francis D.K. Ching, *Architecture: Form, Space, and Order*, 2nd Edition (New York, New York: John Wiley & Sons, 1996), ix.
[30] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 51.

time such as past, present, and future. In both instances architecture can reflect aspects of time. The path of the sun as the earth orbits and the changing of seasons is human civilization's primary measure for keeping time. Likewise, buildings are designed in response to the sun aligned on an east-west axis and anticipated shadows. Some buildings are even designed to align with the sun during the equinox or solstice such as the Mayans did with the Chichen itza pyramid. The various orientations or concepts of time developed in cultures are reflected in the architecture they build.

Culture's relationship to time historically will be referred to as "Past Orientation vs. Present Orientation vs. Future Orientation". This relationship describes how different cultures orient themselves to time in terms of events or periods in time. Hawaiian culture for example, is past oriented because they look to the past to solve present day problems.[31] This orientation can be hard to understand for western culture, as it appears non-progressive. To the past oriented culture, the western culture most likely appears foolish, arrogant, or to have a disregard for the knowledge that can be gained from the past. The historical relationship to time is reflected in architecture by the use of precedents. A precedent in architecture is something that is used to inform design based on the success or knowledge gained from an existing tested example.

Indigenous cultures usually orient time based on natural phenomenon such as changes in seasons or moon cycles. This is largely due to their relationship to nature's cycles that affect their occupational living such as farming. Indigenous cultures understand time through events associated with natural changes such as summer and winter. Hawaiians associate events and ceremonies with changes in climate from summer to winter. Known as the 'wet season' and the hot or 'dry season' Hawaiians understand time by these

[31] Lilikalā Kameʻeleihiwa, *Native Land and Foreign Desires: How Shall We Live in Harmony?* (Honolulu, Hawaiʻi: Museum Press, 1992), 22.

means reflecting their cultural values.[32] Time can also be based on the appearance or location of stars that show the passage of time as it moves across the heavens.

"The concept of the passage of time is very familiar to most people regardless of cultural heritage."[33] Developing the concept of time is a learned aspect of culture not innate. A culture's view of time is an important aspect to the overall understanding of that culture. The expected life span of a building or intended length of use is a result of culture's response to time. Time forms a piece of each culture's identity. Cultural identity is also revealed in the social organization of a community

SOCIAL ORGANIZATION

The social organization of a culture identifies the person-to-person relationships and how the culture constructs them. Three sub-categories clarify the basic social patterns existent in every culture, which are: socialization, family structure, and religion or spirituality. Socialization looks at how individuals or families relate to other people and the general population. Family Structure investigates the family life-cycle traits and generation relationships. Religion examines the belief system and how it gets manifested in public and private settings. For each instance space can be designed in respect to the various social settings.

Socialization is a broader reference to the societal makeup of a culture. This would include things like greetings among people and the general conduct of the culture towards each other. The activities a culture chooses to participate in together reveals their values. For example, dancing may be a significant part of a cultures communication of past

[32] Craighill E.S. Handy, Elizabeth Green Handy and Mary Kawena Pukui, *Native Planters in Old Hawai'i: Their Life, Lore, and Environment* (Honolulu, Hawai'i: Bishop Museum Press, 1972), 28-31.
[33] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 99.

events but not part of their leisure activities. Dancing however, can also serve as a form of a culture's social organization displaying practices for socializing and relating.

In most cultures an important social organization is the family structure. Responsibilities within the family structure are deeply rooted traits of people's beliefs and values tied together by culture. Different ways of living developed in culture become reflected in architecture. The social organization of the family for example could be spread out over great distances or all the members may reside in one building or in close proximity. This is reflected in architecture through layout and relationship of spaces. Family structures have a great deal of influence on broader cultural constructs. "Family member roles are patterns of wants, goals, beliefs, feelings, attitudes, and actions that family members have for themselves and others in the family."[34]

In the indigenous Hawaiian culture an important social structure is the family structure named ʻohana. ʻOhana signifies relatives by blood, marriage, and adoption. As native settlements began to disperse around the land connected through various relationships as family members the word ʻohana came to define an area of land or ahupuaʻa that was settled by a family group. This developed "the identification of persons with family or ʻohana and with the land or ʻaina that nourished the ʻohana."[35]

Religion is part of social organization because it refers to a system of identifying, communicating, and practicing ones spiritual beliefs both publically and privately. Religion is an aspect of social organization, which implies interactive relationships with the other social constructs of a community.[36] Religion is simply a system that identifies

[34] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 76.
[35] Craighill E.S. Handy, Elizabeth Green Handy and Mary Kawena Pukui, *Native Planters in Old Hawaiʻi: Their Life, Lore, and Environment* (Honolulu, Hawaiʻi: Bishop Museum Press, 1972), 287-288.
[36] Joyce Newman Giger and Ruth Elaine Davidhizar, *Transcultural Nursing: Assessment & Intervention*, 4th Edition (St. Louis, Missouri: Mosby, 2004), 80.

what a group of people believes and practice, it is not a belief in itself. Religion can be a powerful mechanism for establishing the core beliefs and values of a group of people that get manifested in architecture.

Social organization influences and is reflected in architecture through differences in class gender, age, generation, lineage, and beliefs. The type, scale, and quality of architecture can be reflected as cultural values regarding a person's social status or class. Architecture can communicate social status among many other aspects of social organization in culture. Similarly, the environment can also influence social organization.

ENVIRONMENT

The environment, which can also be understood as 'land' or 'property', is always a container of a culture's heritage. The cultural heritage of a people includes the works of its artists, architects, musicians, writers and scientists. Cultural heritage is also the work of anonymous artists, expressions of the people's spirituality (religion), and the body of values that give meaning to life. Cultural heritage includes tangible and intangible works of people through which the creativity of that people is manifested in various expressions such as language, beliefs, historic places and monuments, literature, works of art, and architecture.[37] Cultural heritage, especially among indigenous cultures, is often identified with a place.

The environment has the most noticeable effect on culture and architecture. Cultural diversity is partly due to association with natural environment.[38] One aspect of association is the culture's view on the physical control of the environment. Another

[37] UNESCO, "Mexico City Declaration on Cultural Policies: World Conference on Cultural Policies," *United Nations Educational Scientific and Cultural Organization*, August 6, 1982, http://portal.unesco.org/culture (accessed November 10, 2008), 1-4.
[38] Geert H. Hofstede, *Cultures and Organizations: Software of the Mind* (New York, New York: McGraw-Hill, 2005), 16.

aspect of association with the environment is a culture's use of its resources, including food. Indigenous cultures often place their identity in the environment and region in which they live. The environment is central to indigenous culture. They have a profound understanding of the universe and the natural forces of life. For this reason architecture's relationship to the environment is important to indigenous identity.

A culture's management of its environmental resources is a simple way to understand their values. A culture's value of one resource over another or an equal treatment of all resources is a cultural characteristic that gets reflected in architecture. The topography, climatic conditions, vegetation, animal life, and water sources have an influence on culture. Access to large areas of land or ocean resources play a significant role in influencing culture as well. All of these elements are a result of the environment influencing culture and get reflected in architecture. "As climate and physical conditions influence buildings, so they also influence human beings."[39] The environment, which includes geographical features, vegetation, and climatic conditions, is the key component of cultural identity. This is why architecture that can be associated with a place and region is important to creating culturally appropriate and acceptable buildings.

The environment also influences a culture's method of transportation that affects the response to time, space, communication, social organization, and biology. The type of transportation, distance traveled, and time it takes to get from one place to another has a great influence on the general cultural identity. The ocean for example influences island communities and as a result, their ways of living including travel are identified with this environmental aspect. Architecture develops similarly to methods of transportation formed by a culture in response to environment. The final category that makes up the holistic framework for adequately addressing culture in architecture is biology that like environment is a universal aspect of communities that gets reflected in architecture.

[39] Liane Lefaivre and Alexander Tzonis, *Critical Regionalism: Architecture and Identity in a Globalized World.* (New York: Prestel, 2003), 11.

BIOLOGY – GENDER, AGE, ABILITY

The response to biological differences in a culture can have a clear influence on architecture. The gender, age, and physical ability, which include height, weight, and mobility, of an individual and community are unavoidable aspects of culture. Each has an impact on society that transcends into architecture like any other cultural characteristic.

Biological differences of gender, age, and physical ability can be determining factors in how a culture relates socially to individuals. Age for example is used to establish a hierarchy in social situations among many culture's. Each person has a different role and assumed set of responsibilities influenced by their biological makeup. Biological differences become manifested in many aspects of human life. For example, a culture that values physical fitness as a desired quality will have food, clothing, art, buildings (such as gyms), and all other sorts of avenues to accommodate and support that cultural value. Biological differences can be easily overlooked as the cause for uniqueness. The space and size of rooms, furniture, or methods of transportation could be partly due to a culture's biological majority. The biological majority of a culture refers to the fact that the majority of some people group's physical attributes are different than others. For example, some people groups are generally tall in comparison to others. Biology can influence architecture in the same capacity as the other five categories of culture.

It is important to approach a site and design problem with a holistic systematic framework that allows one to appropriately address the aspects of a culture that may be part of their defining identity. Each site and region will have its own cultural priorities that may only focus on a few of the six categories discussed but without a holistic approach something important could be neglected or overlooked.

3.4 CONTEMPORARY STATUS & UNFOLDING TRENDS

Finally, in understanding culture one should address the contemporary status and unfolding trends because culture factors can change. In the attempt to understand and learn about a culture it cannot be overlooked that extenuating circumstances could be affecting the cultures usual patterns. This is an important consideration because the study of that culture could be observing a sudden change in the set of patterns and behaviors. Sudden changes in cultural patterns and behaviors can be because of dramatic historical events such as the attack on Pearl Harbor. Cultural changes can be the result of previous historical events that then later give rise to current unfolding trends. For example, the Island of Kahoʻolawe is specifically part of a revival period in the Hawaiian culture. This is the result of previous dramatic historical events such as the attack on Pearl Harbor, which led to the islands use as a military training area for live fire testing.

Although there is not currently a community of people living on and inhabiting Kahoʻolawe there is very much a culture associated with the island. The indigenous Hawaiian culture has experienced dramatic historical events in the past century. Kahoʻolawe has become identified with a revival in Hawaiian cultural values. As such, Kahoʻolawe's local situation affects the greater Hawaiian culture among the islands. The island has had numerous historical events for its size in relation to the other islands and is currently foregoing a transition period of restoration, which is a direct reflection to Hawaiians cultural values.

Culture is a complex subject. In order to understand a culture fully enough to consider making informed appropriate decisions to reflect that culture, one needs to interact with the culture. The opportunity to interact and consult with the local culture is not always an option in which case a systematic framework for holistically understanding culture is useful. Systematically organizing the different aspects significant in shaping and

revealing cultures characteristics is a good way to obtain a broader understanding with limited time.

Culture is reflected in architecture through but not limited to six avenues: Communication, Space, Time, Social Organization, Environment, and Biology. These avenues construct a framework that encompasses a broad spectrum of cultural characteristics. Some of these avenues may be more prevalent from culture to culture than others. A better understanding of a community is attained as the prioritized aspects of their culture become revealed, helping to inform architecture. Culturally appropriate architecture reflects the values, beliefs, and traditions of the community it serves. Culturally appropriate architecture is infused with traditional knowledge increasing its overall sustainability by its relationship with the surrounding environment.

Cultural identity is typically associated with place and the linked objects and actions. Architecture has the ability to embody and represent cultural values relative to place. This ability makes architecture an important and valuable means for strengthening and representing cultural identity.

3.5 CASE STUDY - CULTURE

The following case study is an example of a culturally sensitive design. This case study shows the process, considerations, and result of consulting with the people who the project is for. This study will investigate the process of integrating cultural values into design and compare the design characteristics with those of a Regional and Sustainable design method.

Key Parameters

Project Name:	Uluru-Kata Tjuta Cultural Centre	
Location:	Uluru-Kata, Northern Territory, Australia	
Architect(s) / Firm:	Gregory Burgess / Gregory Burgess Architects	
Date of Completion:	October, 1995	
Gross Square Footage:	16,000 Square Feet	
Cost:	$7,900,000	
Program:	Indoor Spaces:	Display Rooms, Art Gallery, Multi-Purpose Hall, Shops, Offices, Storerooms, and Plant Rooms
	Outdoor Spaces:	Dance Area, Courtyards, Landscaping
Construction:	Stabilized Earth foundation, walls, floors, and paths. Timber Post & Beam strengthened with steal.	
Building Type:	Community / Commercial / Assembly / Cultural Center	
Design Approach:	Represent the Culture of Anangu	

ABSTRACT

The Uluru-Kata Tjuta Cultural Centre is a respectful modern manifestation of cultural heritage through architecture. Located approximately one kilometer (a little over half a

mile) south from Uluru, a World Heritage Site. Uluru, one of the world's largest monoliths, dominates the plains of central Australia. Uluru and the land around it are home to several unique animal species and the Mutitjulu a community of Anangu who are the aboriginal people of the Uluru Kata-Tjuta National Park. [1] The Cultural Centre is designed to be part of the landscape with an undulating plan capturing the distinctive qualities of the desert landscape and the culture of the Anangu.

The design concept evolved through a collaborative on-site process between the Mutitjulu community, rangers of the Australian Nature Conservation Agency (ANCA), and architect Gregory Burgess along with his consultant team.[2] Burgess lived with the Anangu people for over a month, learning about their culture through song, dance, eating and drinking, and story telling.[3] Through this intimate interaction with the people and land Burgess was able to gain an appropriate understanding of the contextual forces present at the site. The success of the Cultural Centre was not only due to Burgess' cultural understanding but the consultation with the Anangu people. The Anangu people helped create the Centre's form and identify the exact location it was to be sited. The Anangu people were involved in the design process and as a result their cultural values were the main source of inspiration for the design. The Cultural Centre also encompassed significant sustainable design strategies. The materials, construction, site integration, energy and water use, and ventilation strategies are a sophisticated combination of sustainable design principles and cultural values.

[1] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.
[2] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).
[3] Paul Memmot and Joseph Reser, *Design Concepts and Process for Public Aboriginal Architecture*, Paper, Department of Architecture, University of Sydney (Sydney: Plg & Alliled Arts, 2000), 17.

Figure 3.1 Uluru-Kata Tjuta Cultural Centre Aerial Photograph[4]

BUILDING

The Cultural Centre consists of two buildings parallel to each other connected by various outdoors spaces. The Centre carefully weaves together four dissimilar programmatic pieces: a subtle and informative display, an art gallery, shop, and non-public areas-with the landscape.[5] Each piece is placed in within the organic layout of the building.

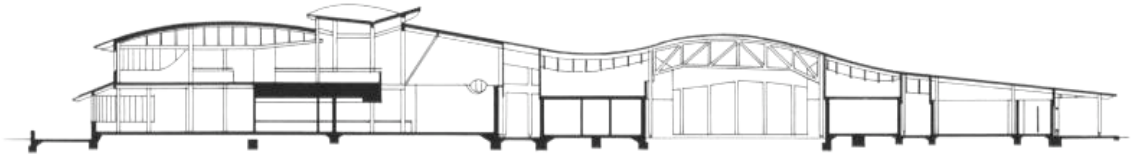

Figure 3.2 North Building Section[6]

[4] Gregory Burgess, "Uluru-Kata Tjuta Cultural Centre Arial Photograph" (image) Available from: SoA Kenneth Brown Design Award, http://www2.hawaii.edu/~kbda/1998-027/index14.htm, (accessed November 14, 2008).
[5] Trevor Mein and Craig Lomotte, "Uluru-Kata Tjuta Cultural Center," *Architecture Australia* 85, no. 6 (Nov/Dec 1996): 60.
[6] Bernard Toogood, "North Building Section" (image) School of Architecture, University of Tasmania, *Uluru Cultural Centre* (Timber Research Unit, 2005).

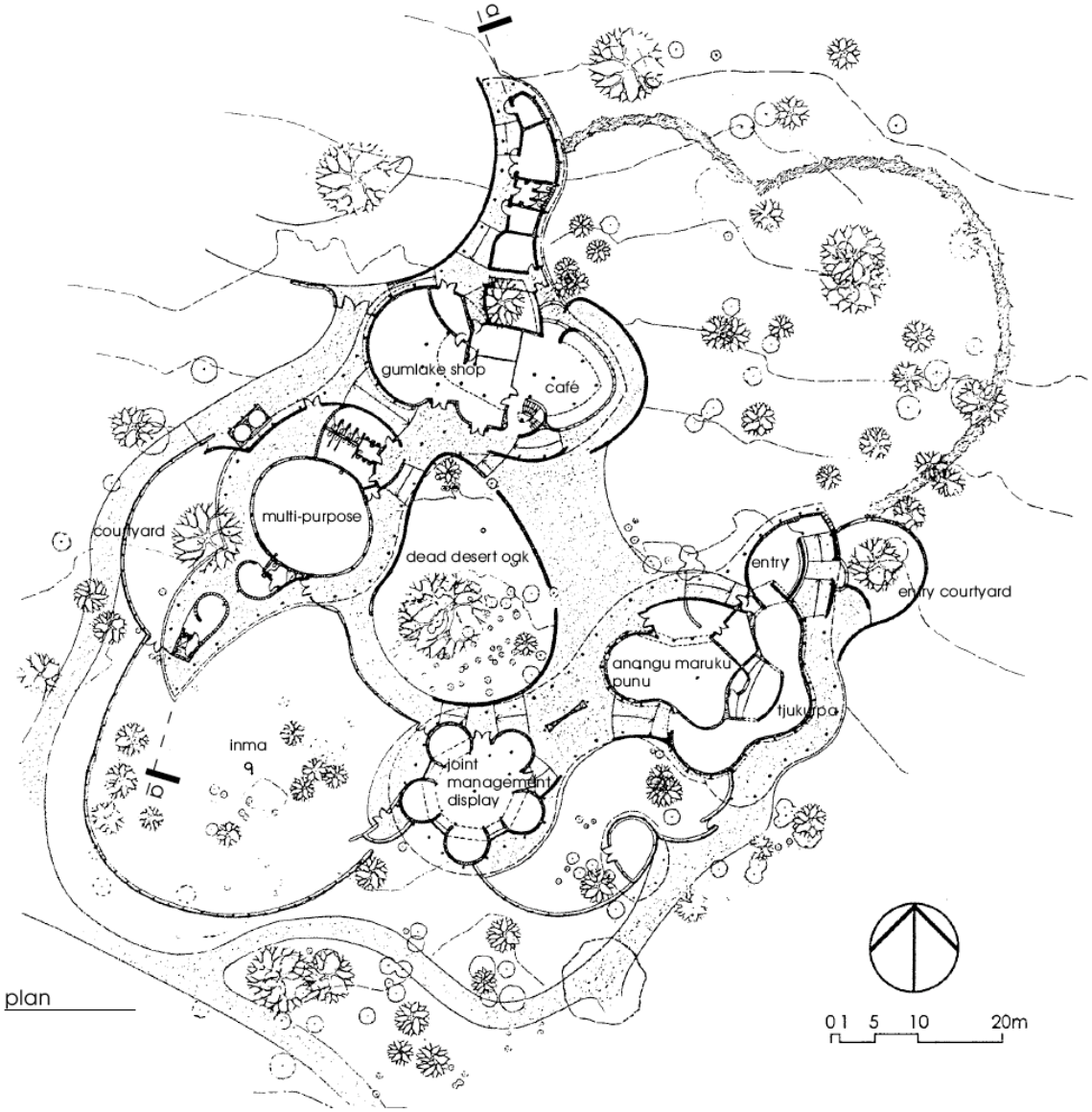

Figure 3.3 Uluru Cultural Centre Plan[7]

Visitors enter the southern building, which contains displays explaining the traditional laws, arts, and crafts of the Anangu peoples, and a display describing the joint management of the park. The northern building contains a multi-purpose hall, shops selling souvenirs and take-away foods, offices, storerooms, and plant rooms. To the west

[7] Bernard Toogood, "Uluru Cultural Centre Plan" (image) School of Architecture, University of Tasmania, *Uluru Cultural Centre* (Timber Research Unit, 2005).

of the buildings is an outdoor space for dances, which will eventually be shaded by vines and complemented by traditional structures. The northeast opens up to a courtyard that frames spectacular views of Uluru.[8] Loosely organized to the flowing contours of the surrounding sand dunes, the two buildings frame in a central courtyard. Fences curving across the desert connect the open space between the two buildings. In the center of the courtyard is an ancient dead desert oak forming the focus the complex.

The two buildings are commonly interpreted as representing Liru and Kuniya, two snakes from Anangu mythology, watching each other across the battlefield. Curving timber and brush walls create various outdoor spaces for dances and other cultural gatherings while interior walls curve in and out of spaces for displays, art galleries, and shops.[9] There is no obvious linear path to take through the building. Visitors are faced with the decision of which path to choose in every space. Circular walls and open timber ceilings of varying height define interior spaces.

The design of the visitor center, unlike conventional projects, had the responsibility of communicating an association of place and culture to visitors (although culture and place go hand in hand). The design communicates a sense of place through building form, circulation paths, and materiality. The design also communicates a sense of the relationships existing in the region between the Anangu and the land and the Uluru park rangers. The relationships are shown through the buildings spatial relationships, new and traditional construction techniques, and the symbolic form of the buildings.

The preservation of the fragile landscape and eco-system was a priority for the building program; therefore, the building itself had to be made with the greatest respect for place. Burgess describes the approaches to it in which “the building appears as a mysterious

[8] Bernard Toogood, *Uluru Cultural Centre*, Case Study, School of Architecture, University of Tasmania (Timber Research Unit, 2005).
[9] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.

undulating presence of skin, light and shadow, emerging and disappearing, looking, approaching, withdrawing."[10] The following quote is to help convey the intended feeling and association visitors to the complex are to experience, as only Burgess could describe it:

> *Red sand, bloodwood and copper are transformed and animated. Sequence is modulated by contrast: of scale, of light and deep shadow, of openness and opacity, of movement and stillness, of weight and lightness. Throughout this rhythmic play, an elusive resonance develops between the building, the culture, the landscape and the visitor - a living field for the introduction of the senses, the heart and the spirit into the mysteries of Anangu knowledge and wisdom." (Gregory Burgess, 1998)*

The associations and feelings Burgess is talking about respond to the use of opposites and contrasts found both in the surrounding environment and the relationship between the indigenous culture and visitor. Throughout the design there are patterns of opposites from inside to out, light to shade, intimate space to endless vista. These sharp contrasts are meant to remove the visitors from their "passive tourist mode, and stimulate them to pause, inquire, think and learn, leaving the Anangu people's land with an understanding of their culture and the landscape of Uluru."[11]

The ceilings are supported in some spaces by large timber columns designed to reflect the image of an upside down tree. The radial saw wood rafters together with the elaborate columns begin to look more the skeletal structure of a snake. The unique aesthetic of the structural system in concert with the play on light gives the experience of being in the belly of the abstracted snakes as one explores the interior space. All of these unique experiences integrated into the Cultural Centre are designed to educate the visitor.

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[10] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).

[11] Bernard Toogood, *Uluru Cultural Centre*, Case Study, School of Architecture, University of Tasmania (Timber Research Unit, 2005).

Figure 3.4 Cultural Centre Radial Sawn Timber[12]

The Centre's strong associations and feelings experienced at the site are designed primarily in attempt to "make visible to the tourists the vibrant landscape of the Park and the way the Anangu are deeply engrained in it."[13] The Cultural Centre is the media through which the Anangu can share their culture in hopes of a better future of understanding and respect for Uluru.

Sustainable design is a given quality of any well thought out design regardless of design objective and the Uluru cultural center is no exception. "Designed to be very energy efficient in this arid zone climate, the building has low running costs because it maximizes natural environmental factors in climate control. Passive energy techniques-massive walls, natural day lighting (shaded in summer) and broad shaded verandahs-are used, with high-tech solar collection, sewage disposal and water recycling. The high mass walls offer a stable internal environment throughout the year."[14]

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[12] Bernard Toogood, "Cultural Centre Radial Sawn Timber," (image) School of Architecture, University of Tasmania, *Uluru Cultural Centre* (Timber Research Unit, 2005).
[13] Lisa Findley, *Building Change: Architecture, Politics and Cultural Agency* (London, New York: Routledge, 2005), p81.
[14] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).

"The upper parts of the roofs are covered in copper tiles, the lower layers which generously offer shade all round the two snake-plans are clad in shaggy bloodwood shingles, a friendly brim to welcome one into the protective shade of the buildings. The building is open to cooling breezes and is designed to maximize convection effects. The little rain that does fall is carefully stored, and water is recycled as much as possible."[15]

"The building opened in October 1995 on the 10th Anniversary of the Uluru-Kata-Tjuta National Park Title Hand back to the traditional owners. Since it has been awarded nationally and published internationally for its architectural qualities, environmental sustainability and effective cross-cultural collaboration."[16] This ceremonial event helped support and solidify the message of healthy cultural exchanges. Almost 500,000 tourists a year make their way to the remote location of Uluru making it a highly recognized site and icon of Australia.[17] Getting the design right and expressing the values of the Anangu was very important.

There are four perspectives of this case study that need to be emphasized: the design process, site, people, and materials. The design process is the most important research objective because it reveals the process taken and decisions made that ultimately resulted in the creation of the Uluru Cultural Centre. The design process identifies the collaboration between the design team and the Anangu people. The site is mutually important because it is the foundation of the Anangu's cultural values and the inspiration for the design. In order to understand the design process and importance of the site it is unavoidable not to emphasize the people involved in the project. Finally, the materials

[15] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.
[16] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).
[17] Lisa Findley, *Building Change: Architecture, Politics and Cultural Agency* (London, New York: Routledge, 2005).

are an important topic to emphasize because they become the manifestation of the design goal. The materials also address sustainable and regional subjects of importance.
How was culture expressed through the architecture? This basic question requires the clear understanding of the entire design process, environment, and host culture. The involvement of the Anangu from the conception of the project to the end of construction and on made the Uluru Cultural Centre a success. The thorough integration of site and materials is pivotal to expressing the cultural perspective to visitors on a daily bases. The Uluru Cultural Centre gave the Anangu a useful tool to effectively share their cultural values.

PROJECT PERSPECTIVES

The following project perspectives are discussed to better understand the design approach taken with the creation Uluru Cultural Centre. This study will specifically discuss the design process along with several major components addressed by the design that includes the site, people, and materials.

When Gregory Burgess was asked in an interview how one even begins to approach a design challenge such as the Uluru Cultural Centre he replied, "You start with all the different forces that you're faced with in a particular place. And you look very carefully and feel very deeply and slowly into a place, and talking with people and working with people, listening to people very carefully. And you begin to gain some insight into how these things might come together."[18] Gaining insight might be an understatement when one considers the time Burgess spent understanding the culture.

"When Gregory Burgess, his colleagues Kevin Taylor and Kate Cullity (landscape architects) and the display designer Sonja Peter were asked to make the building, they

[18] Gregory Burgess, interview by George Negus, *Australian Broadcasting Corporation*, (June 23, 2006).

spent over a month on the site with local people, ingesting the nature of the place by walking it and having it explained by Anangu in paintings, tales and song."[19] Burgess literally camped and lived with the Anangu, which gives a whole other perspective to the pre-design phase of a project. Burgess used his time conceptualizing the project with the people it was going to represent.

Figure 3.5 Collaborative Design Process with Anangu and Park Rangers[20]

"The site was walked, stories of Uluru were mapped and painted by Anangu men and women, and the precise siteing negotiated. The building was carefully located with minimum disturbance to its setting."[21] The architect typically decides the exact location of the building but in this case the "clients" were the ones making the decisions. This unique collaboration with the Anangu ensured the acceptance of the building by the indigenous people and took advantage of the traditional environmental knowledge.

[19] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.
[20] Gregory Burgess, "Working Together" (image) Available from: SoA Kenneth Brown Design Award, http://www2.hawaii.edu/~kbda/1998-027/index06.htm, (accessed November 14, 2008).
[21] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).

With the site defined and agreed upon the actual design of the center involved a similar collaboration with the client but this time more discussion was incorporated. Burgess states that, "in terms of the creation of the building, that was very much a toing-and-froing between some of the elders in the community and myself in those early days where the concept was evolved."[22] Burgess describes interacting more with the Anangu expressing his design ideas and working with feedback from the people. "Drawings of the possible building plan were traced with fingers in the red sand by Anangu, along with many lively sketches of the way the visitors would move though the Centre."[23]

"With the partnership of the Rangers of the Australian Nature Conservation Agency, the community coordinated a meeting and preliminary layouts were sketched out in sand."[24] These informal design charette's resulted in the internationally recognized buildings currently expressing the Anangu's culture today. The design process is clearly understood as a collaborative effort between the Anangu and design team. The consultation with the indigenous culture was the pivotal aspect to the successful design integrating a people's values and the surrounding environmental context.

The site for The Cultural Centre is Uluru. Uluru is a monolith, a geological feature comprised of a single massive stone or rock, which is the center of an area known as the Uluru-Kata Tjuta National Park stretching 1,325 square kilometers (~820 square miles). This park contains a wide variety of "unique fauna such as the Blind Mole, the Giant Red Kangaroo, and the Perentie Goanna, which can out-run a human."[25] The park is also home to the indigenous Anangu people.

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[22] Gregory Burgess, interview by George Negus, *Australian Broadcasting Corporation*, (June 23, 2006).
[23] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).
[24] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.
[25] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.

Uluru rises 348 meters (~1,140 feet) up from the plains of central Australia and stretches out to a circumference of about 9.5 kilometers (~6 miles). Also known as Ayers Rock, Uluru is easily the most recognized feature of the strange and surprising Australian landscape. The name Ayers rock comes from William Goose who named it in honor of governor Henry Ayers after seeing Uluru on a journey across central Australia in 1873. Designated a UNESCO World Heritage Site, initially for its outstanding natural universal values (in 1987), and then for its outstanding cultural universal values (in 1994), the rock is one of Australia's most famous natural features and tourist attractions."[26]

Figure 3.6 Uluru (Ayers Rock)[27]

"Glowing red at times, somber blue at others, and shimmering with quicksilver tracks after rain, Uluru's sandstone, known as Arkose, is naturally grey. When exposed, it

[26] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.
[27] Thomas Schoch, "Uluru (Ayers Rock)" (image) Available from: http://www.retas.de/thomas/travel/australia2005/index.html (accessed May 2, 2005).

weathers to the more familiar ochre color. The rock above the surface of the ground, like an iceberg, represents only a portion of the whole structure. The layers of the rock are almost vertical, showing how the monolith has tilted over the millennia."[28]

Due to the precious qualities of Uluru and its immediate surrounding environment the Anangu, Park Rangers, and design team agreed to locate the Cultural Centre where it would cause the least disturbance to the site. The Cultural Centre is located at the contour where the "sand dunes of the desert meet the microclimate created by Uluru, where bearded grass, umbrella bush and bloodwood trees begin to dominate the desert oaks and spinifex of the endless shifting sandy plains."[29] This transition in the topography and vegetation is rightly recognized as an appropriate location for the Cultural Centre, which also represents a level of transition in cultures. The Cultural Centre is the location of interaction between Uluru, Anangu, Park Rangers, and Visitors.

The main focus of the Uluru Cultural Centre is the people. The Centre is primarily about the Anangu, the aboriginal people of central Australia, but it plays a distinctive role in the integration of Australians in general and visiting peoples with the Anangu culture. The Centre is a place where cultures interact and exchange knowledge and ideas.

To the Anangu Uluru is sacred. It is also an icon for white Australians, embedded deep in the national psyche. To build here, respect for the environment, spiritual as well as physical, was paramount."[30] Even though the Uluru represents different things to each people group it is nonetheless important to both cultures. Uluru is a representation of cultural values.

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[28] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.
[29] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.
[30] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).

"To the Anangu, Uluru is evidence of the creation stories of the Tjukurpa, the Pitjantjatjara word for law -- history, knowledge, religion, and morality that forms the basis of Anangu values and how they conduct their lives and look after their country."[31] Tjukurpa, Anangu law, connects humankind in parallel with the natural world. This means that the Anangu do not view the environment as something they are above or control but rather a force they are continually responding to. The Anangu live by subsistence around Uluru and take shelter in frequent overhangs provided by the rock. In these shelters the Anangu have made paintings and engravings that illustrates stories associated with the country, exploits of the ancestors, and their creation stories."[32]

"The Tjukurpa relate that Uluru -- its individual features, the boulders around its base, the animals and plants that live here as well -- are all part of the past, the present, the land, customs, rituals, and behavior."[33] The Anangu are not able to conceive life without Uluru. Uluru is the Anangu's cultural identity. Their values, beliefs, and traditions are all deeply associated with the rock, which is why the Cultural Centre is a very important bridge to the protection of their identity.

The Park Rangers represent the white Australians attempt to preserve the values their culture places in the national identity derived from Uluru. Park Rangers coincidentally are also made up of members of the Anangu community in an effort to manage the park. The land around Uluru had been reserved for aboriginal people since the 1920s, but the advent of tourism in the 1930s began to impact the landscape. To protect the Uluru area from invasive tourism the site was declared a national park in 1958. "It was later accepted as a Biosphere Reserve under the UNESCO Man and Biosphere Program."[34]

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[31] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.
[32] Ibid.
[33] Ibid.
[34] Ibid.

Uluru is a national park where joint management techniques are being applied to land management and conservation. "Members of the Anangu community at Uluru are actively involved in the administration of the park and its resources, through the running of an office of joint management, participation on the park's Board of Management, and as rangers and tourist guides."[35] The Anangu expressed a desire to work with rangers and strongly conveyed that they wanted the Cultural Centre to reflect the relationship. Burgess commented in an interview that one of the Anangu women said, "we want this building to be reflecting how we Anangu work with the white rangers together as one."[36]

The relationship between the Anangu and rangers is a very important aspect to the long-term preservation of not a rock, but a culture and nations identity. As such the increase in visitors (tourists) to Uluru demanded a way to communicate the importance of the place to the numerous individuals passing through to see and climb on the natural wonder.

The Cultural Centre is essentially designed to be a communication tool for Anangu to share their culture. In an effort to increase the communication of importance to visitors the Anangu introduced various forms of their art throughout the Cultural Centre. The Anangu made "superb Tjukurpa paintings on the sand walls, painted tiles and formed glass which along with ceremonial song and dance cycles, vividly introduce visitors to Anangu perception and culture, before they move on to experience the wider desert landscape."[37]

"About 500,000 people visit the Uluru Kata-Tjuta National Park each year, with international visitation increasing at around 12 percent annually and domestic visitation at 3 percent." As it stands climbing Uluru is still allowed but due to the cultural

[35] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.
[36] Gregory Burgess, interview by George Negus, *Australian Broadcasting Corporation*, (June 23, 2006).
[37] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).

significance and minor safety concerns climbing is strongly discouraged. The Anangu phrase is Nganana Tatintja Wiya, which means "We Don't Climb."[38]
The Cultural Centre is meant to be a place for cultural interaction. The Anangu embraced this idea and because of that the design was a success. The Anangu were willing to share their cultural heritage that allowed Burgess to create the intriguing buildings representing the combination of cultures grounded in the sense of place.

Materials are a significant aspect contributing to the sense of place associated with a building. A building made of materials imported from other regions either says something about the regions resources or the residing culture's values. In this way the Cultural Centre would not be very representative of the indigenous culture if it used materials that were not from or associable to the region. The materials for the Cultural Centre communicate a sense of place and satisfy economies of supply, assembly and future repair. The main construction material of the building used for foundations, walls, floors and paths is stabilized earth made from the sand and gravel of the site.[39] Most of the timbers used are radial sawn sustainable plantation hardwoods and the roof is sheathed in copper and split wood shingles [40]

The large dense mass of the walls helps stabilize the interior temperature by insulating the space through absorbing heat during the day and slowly releasing heat during the night when the temperate drops. In desert climates thermal mass is a good sustainable strategy for maintaining a comfortable living environment. The right choice and use of materials can contribute to a high level of sustainability.

[38] Allison Kealy, Cliff Ogleby, Melissa Johnson and Ben Gunn, "Saving Uluru's Story," *GPS World*, March 2000.
[39] University of Hawaii, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultrual Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).
[40] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.

There are benefits to using a radial sawing method. Radial sawing cuts from the outside of the tree in creating wedge shaped pieces. This makes use of 70 to 80 percent of the tree as opposed to just 30 to 50 percent using the typical back sawn method. As a result substantially less trees were needed to produce the Cultural Centre. Radial sawing also creates stronger pieces that do not shrink as much when drying. Most of the timber used in the building came from the wet temperate forests of Australia's east coast. Minimizing shrinkage is important in the harsh temperatures of the desert climate.[41]

"In the Cultural Centre radial sawn timbers were used as exterior cladding, timber grills, balustrades and internal linings, as well as for structural members. The rafters spanning from the ridge to the perimeter beam are mostly radial sawn Yellow Stringy Bark with some round pole rafters. The rafters support a roofing system of Bloodwood timber or copper shingles on timber battens and plywood."[42]

More traditional methods of lashing pieces together were used to simplify construction. This contributed to the building aesthetic while also making the design more buildable for the local builders. Local knowledge can make a large difference in the performance, cost, and sustainability of design.

ANALYSIS

The following analysis looks at the Cultural Centre in terms of the client, firm/architect/design team, and design. The design is then evaluated on its regional qualities, sustainability, and integration of culture.

[41] Bernard Toogood, *Uluru Cultural Centre*, Case Study, School of Architecture, University of Tasmania (Timber Research Unit, 2005).
[42] Ibid.

A cultural center in theory is designed for everybody, as it is a means for the sharing of culture. The Uluru Cultural Centre was designed for the Anangu to share their culture. Interestingly, the Anangu valued their relationship and mutual effort to preserve Uluru with the white Australians so much that they desired to see it expressed in the design of the Cultural Centre. The client, in the case of the Uluru Cultural Centre, knew what they wanted but more importantly knew themselves.

Burgess was asked if it is easier to design for a people who know their cultural values and who they are to which Burgess replied, "I think that's true."[43] Burgess went on to discuss that the real difficulty in a project such as Uluru is changing one's own perspective in order to understand the values of a people so different from one's own. Burgess described it as a process of listening, talking, and evolving concepts. An important lesson from this study is that the Anangu were willing to share their culture, which may only have occurred because of Burgess' interest in experiencing their values.

Although credit for the project is given to Gregory Burgess it was a collaborative effort and commitment of the design team. Burgess did lead a successful collaborative project. If the Anangu can be commended for their willingness to share their culture, Burgess can be similarly commended for his willingness to listen. Not many architects spend a month living with their client before designing something for them, in fact so far only Burgess does. This emulsion into the culture proved very successful.

Burgess understood the process needed to create an appropriate design for the Cultural Centre. Even if he had no idea what the building would look like he new the inspiration had to come from the Anangu people. Architecture is the physical manifestation of cultural values and therefore impacts people experiencing it whether they appreciate it or not. Burgess new this as he stated, "I think and hope that our buildings do make a

[43] Gregory Burgess, interview by George Negus, *Australian Broadcasting Corporation*, (June 23, 2006).

difference, that they are engaging and engaged with by people and really uplift their lives in some way, [possibly] challenging them sometimes."[44] It is obvious that Burgess was willing draw in the Anangu culture and express it through architecture to impact the visitors coming to Uluru. Burgess used the contextual forces of the Uluru region to inspire the design.

The following analogy describes very well the process, product, and purpose of the Uluru Cultural Centre design. Using natural forms and materials, Burgess and the Mitijulu people has created a simple but sophisticated building. It is not a ridged and predictable design, but a building of rough natural edges, bumps and distortions and natural forms. "The design captures the distinctive qualities of the desert and the culture of the Mitijulu people. But it is also a design that challenges the passive consumer experience of the tourist, leaving them with a meaningful understanding of the place and its peoples."[45]

The design that resulted from the extensive process of collaborating with the Anangu people is without architectural precedent. The design beautifully integrates the environment, Anangu, and park rangers. The Anangu culture is not just represented in the design through form but also material uses and transitions through space. Even though the building's layout are related to the story of two snakes staring at each other across a battlefield it would be more true to relate it to the topography and environmental changes found throughout the park. Desert environments often create illusive scenes and unexpected changes. Likewise the layout and relationships between spaces mimic this phenomenon. The design is very organic in form but that is not due to an architectural exploration of shapes, it is due to an understanding of environment and culture.

[44] Gregory Burgess, interview by George Negus, *Australian Broadcasting Corporation*, (June 23, 2006).
[45] Bernard Toogood, *Uluru Cultural Centre*, Case Study, School of Architecture, University of Tasmania (Timber Research Unit, 2005).

CONTINUITY – REGIONALISM, SUSTAINABILITY, CULTURAL INTEGRATION

Any design with the expressed purpose of reflecting a culture is going to reflect the qualities of Regionalism. Indigenous culture especially demands a Regionalist approach given its usual connection to the land. Regionalism specifically focuses on the importance of a holistic approach, which means addressing all the contextual forces of a given place. Burgess in designing the Cultural Centre began precisely with this holistic perspective. When asked how to even start a project like the Cultural Centre he replied, "you start with all the contextual forces that you're faced with in a particular place."[46] A Regionalist design method is the obvious system for solving a culturally sensitive design problem.

Regionalism developed out of a departure from the placeless modernist style of architecture. Post-modernism similar to regionalism became the term to describe architecture of the modern style attempting to reconnect with place, tradition, and community. Post-modernism did not make use of all the contextual forces to gain inspiration for designs; Regionalism does. As stated by critic Dan Underwood, Uluru "is a truly post-modern building in the best sense of that term, and because it is so multi-layered, it has at least some chance, for some people, in some ways, of making the two very different cultures a little more comprehensible to each other."[47] This statement recognizes the connection the Cultural Centre's design makes to its place while using modern and traditional materials in an effort to express two different cultural values.

The Uluru Cultural Centre is a perfect example of Regional design especially considering its reflection of the Anangu culture. Regionalism is supposed to facilitate the design of appropriate architecture that can be identified with place and people. Regionalism is not

[46] Gregory Burgess, interview by George Negus, *Australian Broadcasting Corporation*, (June 23, 2006).
[47] Dan Underwood, "Snake Charmer," *The Architectural Review* 200, no. 1197 (1996): 46-51.

intended to be limited from the use of new technology or materials, it is simply meant to establish an appropriate use of such things in order to avoid meaningless designs. The Uluru Cultural Centre does just this.

Although academic discussions do not focus on the sustainable aspects of the Cultural Centre, sustainability was not forgotten in the design. It is not that hard however, to achieve a level of sustainability when designing to create an appropriate building identified with place. There are two primary ways the Cultural Centre is sustainable. First, the Cultural Centre's connection to the surrounding landscape and environment of Uluru is a significant step towards sustainability. Second, creating a culturally appropriate building that the local community of people can identify with and value, tremendously increases the care and maintenance of the structure lengthening its useful life cycle and thus its sustainability.

"The two buildings are designed to be energy efficient and are successful in maximizing the environmental factors in climate control."[48] Decisive use of shading and high thermal mass walls contributes the energy efficiency of the structure. Good use of local materials, particularly the radial sawn timber produces a sustainable project. It is of no surprise that a building designed to serve as a tool of preservation for a national park and its residing culture is sustainable. The Cultural Centre would be an insult to the Anangu if it were an environmental irresponsible building.

The important aspect to understand is that sustainability was not achieved through an intense focus on energy efficiency. Sustainability was achieved through an approach to the local culture. Simply representing the Anangu people resulted in easily half of the sustainable aspects of the building. Obviously, shading strategies and measures taken to conserve energy are not a direct representation of the Anangu but these strategies aided in

[48] University of Hawai'i, SoA. *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultural Centre.* 14 November 2008.

the designs overall responsibility to the Uluru environment. Good sustainable practices are nothing new to human civilization it is simply something that got forgotten on the road to development.

The Cultural Centre is good example of cultural integration into architecture. "Through its animated relationship with its powerful site, extensive use of sustainable materials, low energy consumption and its sympathetic responsiveness to both people and the environment, the Centre celebrates the spirit of Anangu culture."[49] In a comparison to other designs integration of culture the Uluru Cultural Centre is easily one of the better examples. This can be attributed to the collaborative design process, and most notably Burgess' month long stay with the Anangu. Most impressive is the designs ability to share the Anangu culture with visitors.

Instead of just creating aesthetic similarities for the Anangu to share their culture and leaving the rest up to displays and galleries, the Cultural Centre's design envelops visitors attacking all of their senses. The unique plays with light to dark, closed to open, and stillness and movement engage visitors to the landscape and culture. Architecture was used as the main tool for sharing the culture of the Anangu.

"This unique integration of indigenous knowledge of nature and traditional land management with western science has proved highly complementary and successful in practice and an inspiration for other initiatives throughout the world."[50] Cultures working together can make a difference in various efforts of interaction around the world. Burgess is not an Anangu but he was able to listen in order to help them share and preserve their culture.

[49] University of Hawai'i, SoA, *1998 Kenneth Brown Award: Gregory Burgess, Uluru-Kata Tjuta Cultural Centre*, http://www.arch.hawaii.edu (accessed November 14, 2008).
[50] Ibid.

PART II

DESIGN

The following section describes a design created using the regional methodology with a focus on culture and sustainability. The design is an archetype that applies the concept developed by this research of Culturally Sustainable Regionalism to the island of Kaho‘olawe. This new design method combines the basic frameworks discussed for understanding Regionalism, Sustainability, and Culture to create place specific, sustainable, and culturally appropriate architecture. This method is implemented based on the design processes discussed in the case studies of this research. Each case study was approached predominately from its respective focus on Regionalism, Sustainability, or Culture. These case studies revealed the design processes that resulted in successful architectural solutions for each site and its contexts.

Culturally Sustainable Regionalism uses the following systematic approach in its design methodology:

REGIONALISM	CULTURE	SUSTAINABILITY
• Environment (related to region/site)	• Environment (related to local culture)	• Sustainable Sites
• Architecture (existing)	• Space	• Water Efficiency
• History	• Time	• Energy & Atmosphere
• Culture	• Social Organization	• Materials & Resources
• Resources	• Communication	• Indoor Environmental Quality
• Technology	• Biology (gender, age, ability)	• Innovation & Design Process
• Politics		
• Economics		

The listed contextual forces are addressed to create a holistic approach to site. These contexts ensure a broad understanding of the region that then allow one to appropriately identify important aspects of the site. These aspects can then be developed into basic design principles, which help to translate the context of site into the physical attributes of architecture. This basic method of identifying contextual aspects and developing design principles based on those aspects is repeated for each of the three focus categories. Once this has been done a small manageable list of design principles embedded with the contexts of a region can be created.

The basic design principles identified and developed for Regionalism, Culture, and Sustainability can then be evaluated and organized to reveal parallel connections between the three categories. This process results in a very focused set of design principles from which a design can be based. The following matrix depicts the system for creating a focused set of design principles as shown in the far left column.

	REGIONALISM	CULTURE	SUSTAINABILITY
DESIGN PRINCIPLE #1	•	•	•
DESIGN PRINCIPLE #2	•		
DESIGN PRINCIPLE #3	•		
DESIGN PRINCIPLE #4	•		
DESIGN PRINCIPLE #5	•	•	•

Contextual Aspects to be Determined from Studying Region

The final step in the design process is using the design principles to evaluate and determine an appropriate precedent that can be used to translate the contexts into an architectural solution. An appropriate precedent helps to make the jump from principles to an architectural solution.

This prototype design methodology isolates contextual variables of a site and uses them as sources of inspiration in architecture. Culturally Sustainable Regionalism aims to provide a usable system for integrating important contexts of site into architecture. This system produces sustainable place specific architecture that reinforces cultural identity.

CHAPTER 4

AN APPLICATION: 'THE CSR-8'

> *"Small Island Developing States are defined by their historic, cultural and economic links to the oceans and seas. They continue to be heavily dependent on their marine resources, particularly for the sustainable livelihoods of coastal communities."*
>
> *(UNESCO, 2005)*

The CSR-8 is the result of applying a hybrid design method, which takes the holistic platform of Regionalism and integrates a focus on sustainability and culture in order to create place specific, sustainable, and culturally appropriate architecture. The CSR-8 is a temporary shelter that is completely self-sustaining, modular, transportable, and adaptable to various locations and terrain in order to maximize the restoration of Kaho'olawe. A specific site was chosen at Lua Makika, which is near the summit of Kaho'olawe Island to demonstrate the actual adaptability to one location. The CSR-8 is estimated to cost between $70,000 to $90,000 that includes renewable energy and water production systems. The design is reflective of the double-hulled voyaging canoe named Hokule'a. The CSR-8's aesthetic and functional representation of the Hokule'a creates a link between traditional and scientific knowledge.

The CSR-8 is designed to support the restoration efforts effectively providing shelter, energy, and water with minimal impact on the landscape producing more than it consumes. The design is intended to reflect a Polynesian sense-of-place clearly identifiable with the regional characteristics of Hawaiʻi specific to Kahoʻolawe. Part of the sense-of-place can be achieved in an appropriate name.

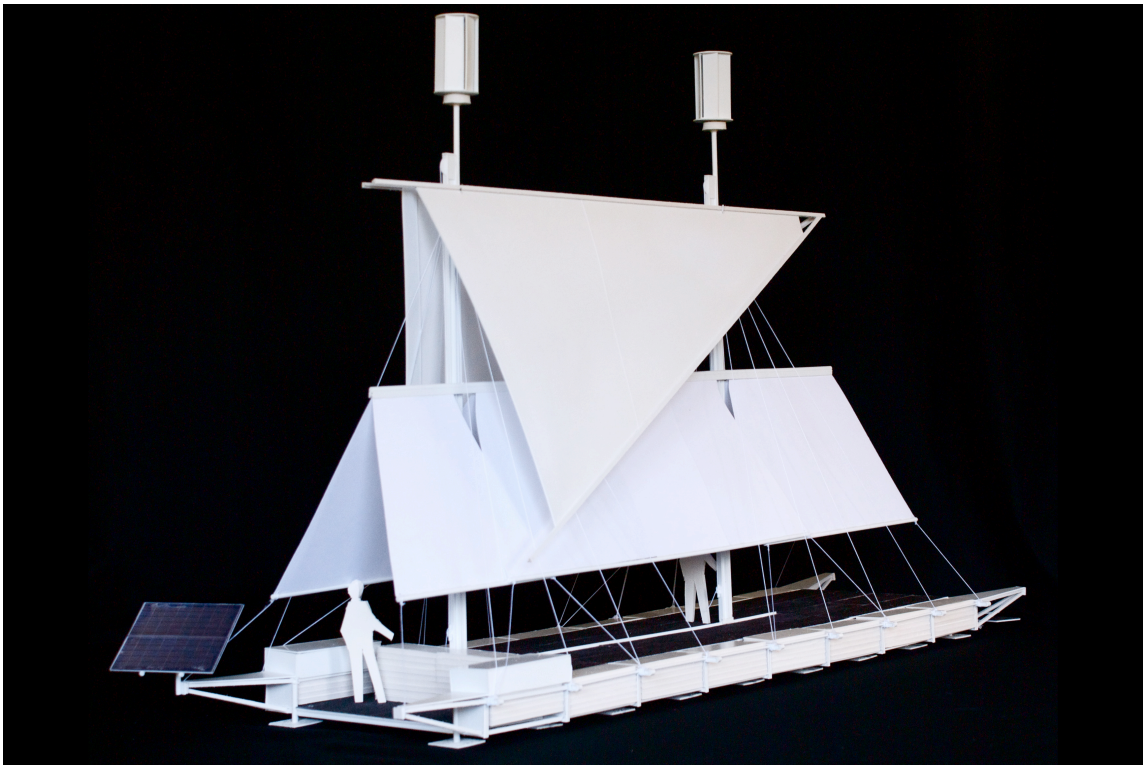

Figure 4.1 CSR-8 Model[1]

The name of the shelter is an important aspect reflecting the indigenous culture of the region. To be consistent with the cultural values represented by the design it is referred to as the CSR-8 only as a model type for the purpose of discussion. CSR-8 is an acronym for Culturally Sustainable Regionalism and eight is a reference to the number of cross beams used in the design. An elder or Kapuna should appropriately name the shelter, as this is the traditional Hawaiian practice. A name may make a connection to the Hokuleʻa and its navigational reference to Zenith stars. The design may also be named according

[1] See Appendix A for model photographs.

to its purpose as a provider to the restoration efforts by supplying shelter, water, and energy. A suitable name may even describe the characteristics of the design such as its ability to be transported, adapted, and self-sustain. In either case the name chosen will allow the design to better represent the values of the indigenous culture and thus increase its sustainability and regional quality.

4.1 INSPIRATION

This research focuses on the applicability of regional contexts with increased attention to sustainability and culture as sources for design inspiration. A significant argument of this research is that cultural values inspire design. As such, it is important to discuss the design process that lead to the creation of the CSR-8 in order to properly evaluate the methodology of Culturally Sustainable Regionalism.

One of the first steps in any design is evaluating the site where it is to be located. The site specifies many of the contextual forces specific to the region. These forces include the environmental conditions, culture, and sustainable aspects.

Kahoʻolawe was selected as the prototype site for this research because of its need for culturally appropriate architectural solutions that are sustainable and promote the Hawaiian culture. "Kahoʻolawe, the smallest of Hawaiʻi's major islands, consists of forty-five square miles of volcanic craters, hills valleys, rugged cliffs, and sandy shorelines, with near shore reefs and deep ocean channels."[2] Kahoʻolawe is in the rain shadow of Maui resulting in most of the island appearing similar to the leeward side of the bigger islands. Kahoʻolawe is only 1,477 feet above sea level at its highest point Puʻu

[2] Davianna McGregor, *Nā Kuaʻāina: Living Hawaiian Culture* (Honolulu, Hawaiʻi: University of Hawaiʻi Press, 2007), 251.

Moaulanui, which is very low compared to its neighboring volcanic mountain Haleakala on Maui reaching 10,023 feet above sea level.[3]

Kaho'olawe has had an impactful history that has left it scared and unable to sustain a human population of even small numbers. The written history of Kaho'olawe begins in 1779 with the accounts of early explorers such as captain's James Cook and George Vancouver. The islands written history can be divided up into eight distinct periods:

- Early Contact Period (1779-1825)
- Missionary Period (1825-1853)
- Early Ranching Period (1853-1910)
- Forest Reserve Period (1910-1918)
- Later Ranch Period (1918-1941)
- Military Period (1941-1980)
- Joint-Use Period (1980-1994)
- Restoration Period (1994- present)

Due to over grazing and live-fire testing by the military Kaho'olawe is severely eroded and most of the island declared unsafe because of unexploded ordinance. This unfortunate series of events is the reason for the restoration efforts being conducted presently. Major historical contexts should be addressed in the architecture proposed for the island because of the impact they have on its identity. However, the proper use of the historical context only comes from integrating it with the other regional contexts specifically, an understanding of the indigenous culture and environmental concerns.

An important context of Kaho'olawe, distinct from the other major islands, is its recognition as the navigational center of the Hawaiian Islands. "Oral traditions identify Lae o Kealaikahiki (an area on the West side of Kaho'olawe) as the major point of

[3] Kaho'olawe Island Conveyance Commission, "Kaho'olawe: Restoring a Cultural Treasure," Final Report of the Kaho'olawe Island Conveyance Commission to the Congress of the United States (Maui, March 31, 1993), 16.

departure for Hawaiians leaving for Tahiti in the thirteenth century."[4] Recent archaeological research provides evidence that Kaho'olawe was indeed a significant component in the Polynesian seafaring and navigation activities prior to western contact. In 2007 the following evidence was discovered supporting the voyaging histories of the Hawaiian people in relation to Kaho'olawe:

> "Scientists Kenneth Collerson and former Bishop Museum researcher Marshall Weisler of the University of Queensland report that their trace elements and isotopes analysis of a basalt adze, collected on the Tuamoto island of Napuika, could be traced only to Kaho'olawe. The discovery became the first "hard evidence" that Hawaiian oral histories of the Long Voyages between Hawai'i and Tahiti were factual."[5]

Attention should be given to the essential maritime aspects of the indigenous culture. Island regions specifically have a strong connection to the ocean as a sustaining resource.

Kaho'olawe in the recent decades has become the center of the first cultural renaissance in Hawai'i since the impacts of western contact.[6] The entire island is considered sacred thus having great implications on any new construction on the land. Choosing a specific site was very important because each site on Kaho'olawe brings with it specific environmental, cultural, and regional contexts unique from other areas around the island. Allowing for adaptability to the specifics of different sites around the island became imperative to the design.

The specific site chosen for the CSR-8 was the result of consultation with the indigenous culture, research from the original use plan, attending a presentation of the new cultural

[4] Davianna McGregor, *Nā Kua'āina: Living Hawaiian Culture* (Honolulu, Hawai'i: University of Hawai'i Press, 2007), 258.
[5] Kaho'olawe Island Reserve Commission, *Kaho'olawe*, http://kahoolawe.hawaii.gov (accessed March 25, 2009).
[6] Davianna McGregor, *Nā Kua'āina: Living Hawaiian Culture* (Honolulu, Hawai'i: University of Hawai'i Press, 2007), 249.

use plan, and observation of the restoration efforts on the island. This method of gaining insight and inspiration is derived from the lessons learned studying the Uluru Cultural Center's design process. Unfortunately, indigenous consultation for the design of the CSR-8 was limited in comparison to the consultation for the Uluru Cultural Center. During the design process the Use Plan originally created for the restoration of Kaho'olawe was consulted. The Use Plan identifies specific areas around the island and specifies intended uses for these areas. In particular, six areas were proposed to have Kahua Kauhale (educational and cultural centers / work camps). The Kahua Kauhale's are intended to support larger groups for educational as well as restoration activities. The important information gleaned from this research was that there is a need and intended use for specific areas to contain support structures for education and restoration activities.

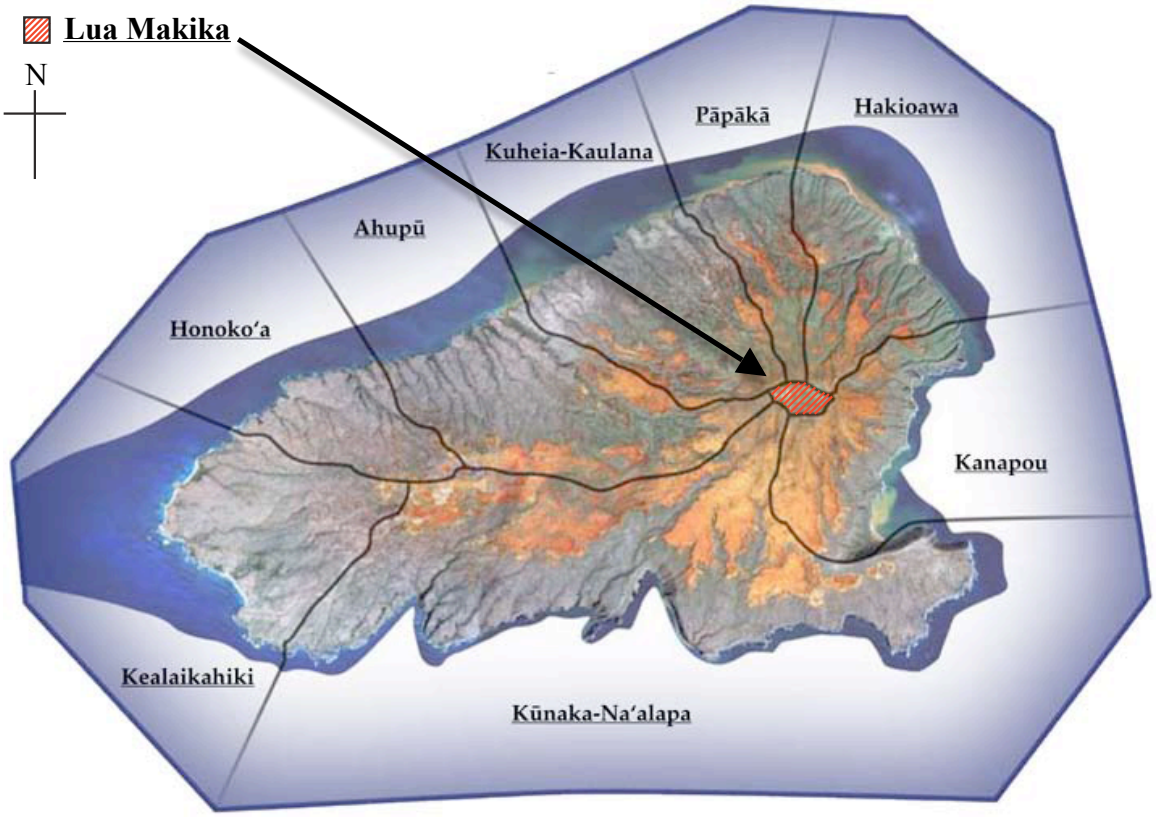

Figure 4.2 Map of Kaho'olawe[7]

[7] KIRC, "*Map of Kaho'olawe*" (image) http://kahoolawe.hawaii.gov (accessed March 25, 2009).

Ultimately, Lua Makika was determined as the best site because restoration activates have already begun in that location. A localized support structure would avoid the resource consuming commute from the current base camp at Honokanai'a, which is almost an hour away by vehicle. Lua Makika literally translated means "Mosquito hole" that makes reference to the water that would collect in the caldera after a rain and attract mosquitoes. Lua Makika is the current name for the center of the island from which most of the 'ili radiate. Lua Makika is not considered an 'ili. [8]

'Ili are divisions of land within the basic pattern of land use called ahupua'a. Ahupua'a, often pie shaped, are land divisions that run from the mountains to the sea or reefs affording the people living on the land access to the resources of the mountains and the ocean. Kaho'olawe is an ahupua'a within the Maui district of Honua'ula. Kaho'olawe is currently divided up into eight 'ili, condensed from twelve original divisions, each defined by various watersheds that run from the central ridge of the island.[9]

Lua Makika is the highest area on Kaho'olawe and receives approximately 25 inches of rain per year making it ideal for water storage and distribution to radiating 'ili. The average constant wind speed near the summit is 15.9 mph out of the northwest offering ideal conditions for the use of wind power for energy production.[10] Archaeological evidence, along with traditional accounts, indicates that the area was a very important training center for early navigators in the art of way finding. The summit offers unobstructed views all around the island. Currently, the area is used for navigational training with a traditional star compass, overnight camping, support for educational and restoration activities, and a storage area.

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[8] PBR Hawaii, *Kaho'olawe Use Plan: Palapala ho'onohonoho moku'āina o Kaho'olawe*, Report (Honolulu: PBR Hawaii, 1995), 7-19.
[9] Kaho'olawe Island Reserve Commission, *Kaho'olawe*, http://kahoolawe.hawaii.gov (accessed March 25, 2009).
[10] West Regional Climate Center, *Historical Climate Information: Kaneloa*, http://www.wrcc.dri.edu (accessed February 5, 2008).

Lua Makika is an ideal location for a temporary structure to support the educational and restoration activities underway in the area. The area is currently supported by Honokanai'a base camp nearly 10 miles away on rough unpaved roads. Identifying a specific site not only shaped physical attributes of the design but also helped to inform the program.

The basic program includes a multipurpose space for living, sleeping, and meeting, a kitchen, and storage. The CSR-8 is not a traditional building but more like a boat by how it functions. The CSR-8 provides sheltered space for food preparation, meeting, sleeping, storage, and communication equipment but it also produces and stores energy and water.

Originally, the program focused on three basic spaces that were, a multipurpose space, kitchen, and office. Once Lua Makika was identified as the site for the project, the program was refined to meet the climatic and use needs of the site and surrounding area. The needs for the site revealed that a structure was needed that could provide shelter for twenty people for cooking, meeting, sleeping, and storage. The structure also needed to provide energy for cooking, water pumping, refrigeration, lighting, power tools, and communication equipment along with a water supply. The program changed from a structure that provides a few basic needs to a self-sustaining structure that provides all the needs for twenty people for four-day durations.

The CSR-8 was also shaped by various design principles developed simultaneously with the site selection and program. This was done primarily to capture a holistic approach to the region's contexts. To stay consistent with the research, numerous design principles were developed according to the focus on regionalism, culture, and sustainability. The following design principles represent the contextual forces initially identified:

REGIONALISM
- Natural Energy Resources
- Imported Materials
- Orientation-Topography/Wind
- Isolation
- Lightly Touch the Landscape
- Microclimates
- Indoor/Outdoor Space
- Sovereignty to protect 'aina
- Axis of Culture

CULTURE (Hawaiian)
- Way Finding Center-Navigation
- 'Ili-Land Divisions
- Subsistence Living
- Mountain & Ocean Views "Seeing, Hearing, Feeling the Landscape"
- 'Ohana Space
- Chants & Dance
- Cultural Renaissance
- Informed by the Past

SUSTAINABILITY
- Renewable Energy Source
- Effective Water Production/Use
- Passive Ventilation and Cooling
- Ancestral Knowledge of the Land
- Adjustable Skin
- Multiple Design Strategies
- Community Interdependence

From this basic list several principles were selected from each category for further development. The following are the principle design elements that were influential in the initial conception of the CSR-8:

REGIONALISM

NATURAL ENERGY RESOURCES

The abundance of solar energy available through light, wind, and tidal forces throughout the islands is a resource that should not be overlooked. A building should be designed to harness this available energy to effectively provide for its means. Specific site conditions for the appropriate energy resource use are an important consideration.

ISOLATION

The Hawaiian Islands are one of the most isolated regions in the world located in the middle of the Pacific Ocean thousands of miles from land. This recognizes the necessity of imported materials and highlights the use of as much locally available resources as possible. Kaho'olawe requires materials that can be transported by boat and then once to the island transported by vehicle or hand. The isolation of the island also eliminates the availability of heavy machinery for construction. This isolation implies the use of self-supporting strategies of design.

TRADE WINDS

Consistent wind patterns should be addressed in design. Architecture should be responsive to the prevailing winds with proper orientation and use of this available force. Winds turbines are a good use of this wind resource.

MICROCLIMATES

The recognition of microclimates means understanding the necessity of place specific design. Every site has specific environmental characteristics that set it apart from other sites. The Hawaiian landscape has numerous microclimates that range from wet tropical jungle to dry desert.

LIGHTLY TOUCH THE LANDSCAPE

Buildings should lightly touch the landscape both from a functional and culturally respectful perspective. The land, specifically on Kaho'olawe, is considered sacred. A building should be designed to respect this value. In addition, the physical character of rock, coral, and sloping terrain must be considered.

CULTURE

CENTER OF NAVIGATION

Kaho'olawe is the navigational center of the Hawaiian Islands; as such, design should reflect this heritage of the island. Just as a boats form is dictated by its functional purpose so should architecture be as well.

'ILI

The unique divisioning of land creates a relationship between the mountains and ocean that defines natural boundaries of a site. Design should reflect these boundaries through building oreintation and orgainization of space. Design should identify with the specific 'Ili in which it is located.

SUBSISTENCE LIVING

This principle recognizes the importance and value of subsistence living to the indigenous culture. Design should go beyond shelter and aim to support the lively hood of the community it is for. This means producing energy, water, and other necessary components for the survival of its users. More importantly, this means responsibly using the resources of a site.

MOUNTAIN & OCEAN VIEWS "SEEING, HEARING, & FEELING THE LANDSCAPE"

The sense of a place can be easily gained from the powerful image of the mountains and ocean that define the islands. Design should make connections to the mountains and ocean by providing views, openings, and textures that stimulate the user's senses to communicate the characteristics of place.

INFORMED BY THE PAST

Design should reflect lessons learned from previous structures and events. Design qualities that worked or failed in previous buildings should inform the design. Extreme weather events or other historical events such as wayfinding training should inform aspects of the design.

CULTURAL RENAISSANCE

Kaho'olawe is the foundation to the renaissance of Hawaiian culture. The land holds the value and identity of the indigenous culture. Dances, chants, and a mission to protect the land should be reflected or reinforced by the design. Symbols and other strong components of the cultural identity should be used to inspire qualities of the architecture for the region.

SUSTAINABILITY

EFFECTIVE WATER PRODUCTION AND USE

Water is a precious resource that should be collected or produced and responsibly used. Design can dictate the effective production and use of water. The ability of a structure to work with a community of buildings reduces wasteful contingencies. Water collected by multiple roofs can be channeled into one collection tank. Wastewater from a community of buildings creates an opportunity for more effective irrigation use of otherwise useless water.

PASSIVE VENTILATION

In a climate that rarely fluctuates in temperature more than ten degrees in a given year, passive ventilation must be the primary means for thermal comfort. Proper passive ventilation ensures a healthy sustainable interior environment.

MULTIPLE DESIGN STRATEGIES

This principle recognizes the value of not just one sustainable design strategy but multiple strategies. Multiple sustainable strategies result in an increased level of sustainability.

ADJUSTABLE SKIN

The ability for a building to adjust to best accommodate the current climatic conditions is extremely beneficial. The use of shading devices, operable openings, and wind scoops all give the building a level of control offering comfort and protection to the user. Just as a flower responds to changes in the environment by opening and closing so should a building.

COMMUNITY INTERDEPENDENCE

The spirit of 'Ohana is captured in this design principle. The strength of combining resources and handling waste as a community is far more effective than self-supporting structures. Self-supporting structures have to produce more energy or water than is actually necessary in order to protect against worst-case scenarios. The excess power of one building can be used for another buildings needs. Buildings that work together drastically reduce the waste of contingencies and efficiently use the resources of the land.

Further refinement of these design principles identified commonalities across the three categories of regionalism, culture, and sustainability. Identifying these commonalities helped to consolidate the previously numerous contextual forces into five simple principles, as seen in the matrix below.

	REGIONALISM	**CULTURE** (Hawaiian)	**SUSTAINABILITY**
RENEWABLE	• Natural Energy Resources	• Subsistence Living • Ancestral Knowledge of Land	• Renewable Energy Source(s) • Effective Water Production / Use
RESPONSIVE	• Microclimates • Orientation–Wind, Topography, Rain, Vegetation	• Ahupua'a & 'Ili • Boundaries	• Adjustable Skin • Passive Ventilation and Cooling
CONNECTED	• Indoor/Outdoor Space • Land & Sea	• Mountain & Ocean Views "Seeing, Hearing, Feeling the Landscape"	• Site Development • Healthy Interior Space
TRANSPORTABLE	• Isolation • Imported Materials	• Way Finding Center-Navigation	• Multiple Design Strategies
HERITAGE	• Axis of Culture • Sovereignty to protect the 'Aina • Lightly Touch the Landscape	• Cultural Renaissance • Chants & Dance • 'Ohana • Informed by the Past	• Community Interdependence • Shared Responsibilities

The five principles renewable, responsive, connected, transportable, and heritage guided the design process insuring a holistic final product. The following five design principles formed the bases from which the characteristics of the CSR-8 are developed. Each of

these principles, as it has been shown, contains numerous aspects of the regional context addressed in the design of the CSR-8.

RENEWABLE

The CSR-8 reflects a responsible use of the natural energy resources of the region. A responsible use of these resources is achieved by using renewable strategies for both energy and material selection. Capturing the abundant solar energy both in the form of light and wind allows the CSR-8 to be self-sustaining. The CSR-8 displays an awareness of the site and region recognizing natural cycles.

RESPONSIVE

The CSR-8 responds to its site and region. The environmental characteristics of a site and region are in constant fluctuation thus the CSR-8 is able to adapt to given conditions of the moment. Shelter adapts to the climatic conditions by the use of adjustable components. The Hawaiian region has many microclimates with sharp contrasts in environments from wet and tropical to dry and arid with little distance in between. The CSR-8 addresses these boundaries and changes through orientation to various natural forces of the site and an adjustable passive ventilation strategy. The CSR-8 responds to regional forces such as wind, topography, rain, vegetation, and astrological movements including the sun, moon, and stars.

CONNECTED

The CSR-8 makes connections to the land and ocean by providing an open system of shelter and nautically inspired design that stimulates the users senses to the characteristics of place. A sense of place can be easily gained from the powerful image of the mountains and ocean that define the region. The design reflects the importance of connection to the land and sea. The quickly adjustable system of shelter keeps the user closely connected to the environment through awareness in changes of climatic conditions.

TRANSPORTABLE

The ability of the CSR-8 to be easily transported, assembled, and disassembled is a direct reflection of the regions isolated qualities. Isolation implies self-supporting strategies of design. The Hawaiian Islands are self-sustained through the use of maritime skills. Kaho'olawe is the navigational center of the Hawaiian Islands; as such the CSR-8 reflects this heritage of the island. Just as a boats form is dictated strongly by its functional purpose so is the CSR-8. It uses multiple design strategies, similar to the Hawaiian Gateway Energy Center, based on modular components to create a transportable sustainable design. The modular components of the CSR-8 make it easily transported by helicopter, boat, truck, or even by hand with a group of people.

HERITAGE

Kaho'olawe is the foundation to the renaissance of Hawaiian culture. The land holds the values and identity of the indigenous culture. The mission to protect the land is respected in the CSR-8's light impact on the landscape. The CSR-8 is informed by the past in its strong inspiration from the Hokule'a, a symbol of the Hawaiian seafaring heritage. The Hokule'a was a catalyst for a generation of cultural renewal and likewise its symbolism is appropriately brought ashore in CSR-8's design. The CSR-8 utilizes the value of community interdependence capturing the concept of 'Ohana.

This system of identifying regional contexts then translating them into design principles is adapted from the example of Troppo architects 'Ten Thematic Constants' developed for the design of the Green Can. The difference between Troppo's example and this projects method is the inclusion of the three categories regionalism, culture, and sustainability rather than one. The inclusion of these categories balances culture, sustainability, and regionalism in result, making sure the design process appropriately addressed these important contexts in the overall method of Regionalism.

Included in the design process along with the site evaluation, programming, and design principles was basic conceptualizing. Conceptualizing is the first representation of the program and design principles in three dimensions. The initial design sketches were based on the simple triangular geometric patterns used by the indigenous Hawaiian culture. This method quickly revealed the need for a precedent.

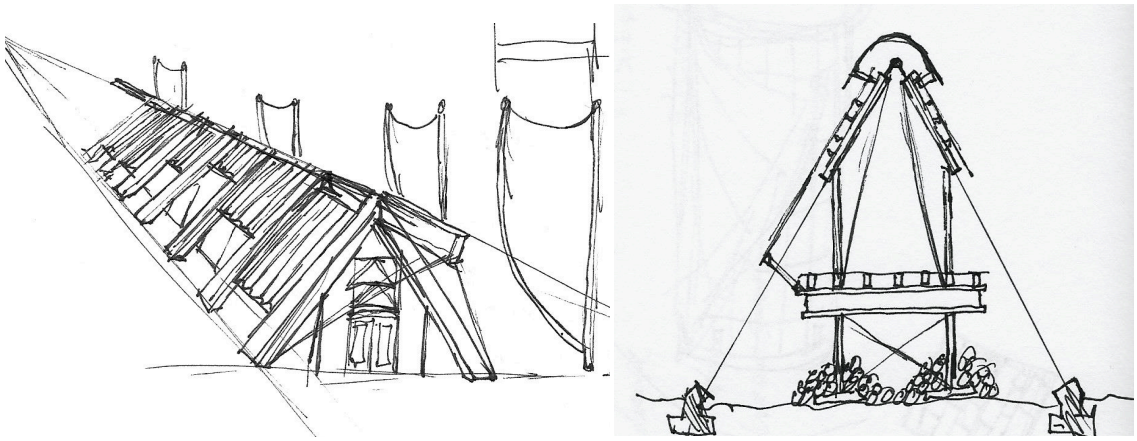


Figure 4.3 Initial Concept Sketches

The first precedent looked at the traditional Hawaiian building or hale. Immediately this raised questions of the kind of architecture this precedent would produce. It was quickly realized that using the hale as a precedent would guide the design closely to the vernacular style of design. Using the hale as a design precedent would ultimately produce a hut using modern materials. This would fail to appropriately address the contextual forces of today and lock the idea only in the past. The past should inform the design but in balance with the contexts of today anticipating the future.

Further research for a precedent included looking for something that would create a link to the past yet was relevant today and supported the idea of transportability. A review of the history of Kaho'olawe pointed to the sea faring heritage of the island and the double hulled voyaging canoes. The canoes were the perfect type of precedent for a transportable self-sustaining structure that represented the indigenous cultural values yet

had relevance today. With the selection of a precedent the design process turned to analyzing the voyaging canoes and translating components into the design of the CSR-8.

4.2 PRECEDENT – HOKULE'A

Upon investigating voyaging canoes the Hokule'a stood out as an appropriate representation of the indigenous sea faring accomplishments. Hokule'a is the re-creation of the traditional double-hulled voyaging canoes, as no examples of actual voyaging canoes exist today.

Figure 4.4 Hokule'a Sailing to Tahiti in 1976[11]

"Since 1976, Hokule'a has completed ten successful voyages and is recognized today as a major catalyst for cultural renewal throughout the Pacific and is a symbol of the richness of the Hawaiian culture's seafaring heritage that links the peoples and cultures of Polynesia and the Pacific together as 'ohana."[12] Artists employed by early explorers designed the Hokule'a based on drawings of canoes. The primary purpose for reconstruction of the ancient voyaging canoes was to challenge the notion that Polynesia

[11] Ben Finney, "Hokule'a sailing to Tahiti in 1976" (image) in *Vaka Moana: Voyages of The Ancestors*, ed. Kerry R. Howe, 100-153 (Honolulu, Hawai'i: University of Hawai'i Press, 2007), 130.
[12] Polynesian Voyaging Society, "The Legacy," http://pvs.kcc.hawaii.edu (accessed March 27, 2009).

was settled by accident, by sailing a similar canoe without instruments over the legendary voyaging route between Tahiti and Hawai'i.[13]

The theory challenging the Polynesian settlement was written by a retired New Zealand civil servant named Andrew Sharp. Ben Finney, a student at the University of Hawai'i at the time, was intrigued by Sharp's paper. Finney quickly realized that sources available on Polynesian voyaging at the time did not provide sufficient evidence to settle the debate. Over the next twenty years Finney earned a masters degree from the University of Hawai'i, a PhD at Harvard, taught classes at the University of California Santa Barbara, and eventually took a position at the University of Hawai'i. In 1973 Finney founded the Polynesian Voyaging Society (PVS) to develop community support for the construction and voyage of the Hokule'a to Tahiti.[14]

The first voyage of the Hokule'a was not without incident. Several Hawaiians identified strong cultural pride with the Hokule'a and protested the inclusion of non-Hawaiians on the voyage. Despite the protest the Hokule'a sailed anyway. This protest developed into a confrontation among crewmembers aboard the Hokule'a that lead to blood on the deck. Disgusted by the event, navigator Mau Piailug flew home scraping the return voyage to Hawai'i. A group of Hawaiian educators and community leaders took over the PVS and attempted to sail back to Tahiti without consulting the most experienced members of the first voyage. Unfotunately, renowned surfer Eddie Aikau died after the Hokule'a capsized between O'ahu and Moloka'i. After these events Myron Thompson was elected president of the PVS and rebuilt it based on positive Hawaiian values of 'imi 'ike

[13] Ben Finney, "Polynesian Voyaging," in *The Wayfinding Art: Ocean Voyaging in Ancient Polynesia*, ed. Carl Sneider and Will Kyselka, 11-15 (Berkeley, California: Regents of the University of California, 1986).
[14] Ben Finney, "Renaissance," in *Vaka Moana: Voyages of The Ancestors*, ed. Kerry R. Howe, 288-333 (Honolulu, Hawaii: University of Hawai'i Press, 2007).

(seeking knowledge), a'o (learning, teaching), lokahi (unity), and malama (to care for) that guide the society today. [15]

The importance of understanding this history recognizes the incredible impact cultural values have on the success of a project. Improperly addressing the indigenous cultural values can take a good well-intentioned idea and negatively impact its ultimate success. Similar to the Hokule'a the CSR-8 integrates cultural values; therefore, understanding the Hokule'a's history, purpose, and design were essential to properly using the precedent.

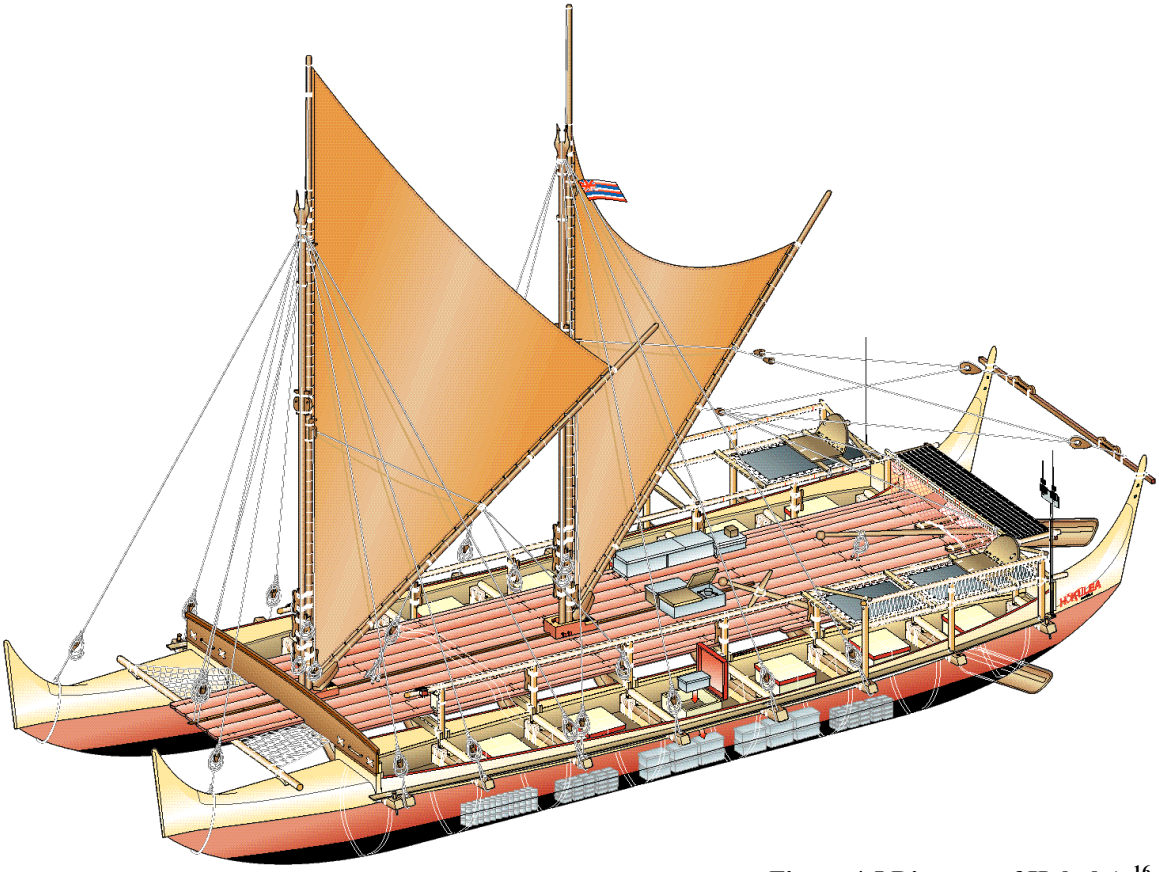


Figure 4.5 Diagram of Hokule'a[16]

[15] Ben Finney, "Renaissance," in *Vaka Moana: Voyages of The Ancestors*, ed. Kerry R. Howe, 288-333 (Honolulu, Hawai'i: University of Hawai'i Press, 2007), 299-302.
[16] Polynesian Voyaging Society, "Hokule'a" (image) http://pvs.kcc.hawaii.edu (accessed March 27, 2009).

After selecting the Hokule'a preliminarily as an appropriate precedent, the design process turned to investigating the design and construction of the canoe. This process provided enough understanding to enable the translation of components of the Hokule'a and imposed values into the design of the CSR-8.

The Hokule'a is a replica of a double-hulled Hawaiian voyaging canoe. It is approximately 60 feet long from bow to stern, 17 feet across the beam, and has two masts almost 30 feet high. The canoe consists of two hulls narrowly spaced and lashed together using eight crossbeams equally distanced. There is a deck laid on top of the crossbeams as well as a longitudinal beam. The deck planks, made of modern 2x10 boards, are spaced to allow water to drain. The longitudinal beam spans the crossbeams to provide uniform support for the masts held in place on the longitudinal beam by a mast step. The masts are secured vertically by eight stays each tied to the end of the four nearest crossbeams.

The shade sails are triangular held to the masts by a spar on one side of the sheet and held open by a boom on the other. Halyard lines used for hoisting the sails run through a horn at the top of the masts. Sheet lines open the sails and hold them in place. A giant paddle is used for a rudder at the stern of the canoe.

The canoe is designed to carry all the supplies needed to sustain a crew of about twelve for up to 40 days. Many of the supplies are stored in the hulls of the canoe. Cooking is done on deck by use of propane burners housed in a metal container. Those of the crew that get to sleep, sleep in the hulls covered by canvas secured to railings required by the cost guard. Shelter for the navigator and those steering the canoe is provided using a tarp stretched over lines from the mast to stay on course during rains at sea. 407 gallons of water and 2,000 lbs of food are brought on the voyage but fishing and water collection from the sails are used to replenish supplies. Some modern equipment is brought such as

a small solar array and battery to power a radio for communications along with a GPS and locator beacon for emergencies. Most of the modern equipment is for emergency purposes.[17]

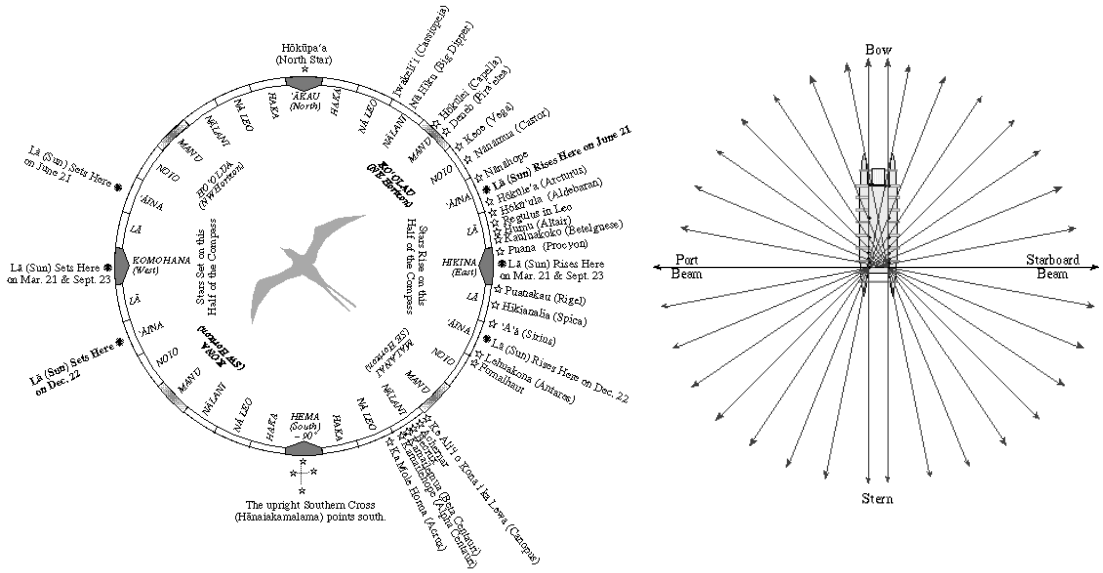


Figure 4.6 Hawaiian Star Compass[18]

Further research of the Hokule'a proved that the voyaging canoe was an ideal precedent for the CSR-8 both in literal components and layout as well as a link between traditional and scientific knowledge. One such link is the development and use of the Hawaiian Star Compass. The Star compass is part of the system of navigating without modern instruments. Nainoa Thompson developed the currently known version of the Hawaiian Star Compass as part of the mission of the Hokule'a to rediscover the vanished art of wayfinding. Thompson drew on knowledge from the Micronesian Star Compass with western notions of equal divisions of the circle, and uniquely Hawaiian concepts. The compass is based on where stars and celestial bodies rise and set, and indicators from the

[17] Polynesian Voyaging Society, "Canoe Life," http://pvs.kcc.hawaii.edu (accessed March 27, 2009).
[18] Polynesian Voyaging Society, "Hawaiian Star Compass" (image) http://pvs.kcc.hawaii.edu (accessed March 27, 2009).

natural environment for staying oriented.[19] The compass is divided into 32 houses each 11.25 degrees totaling 360 degrees. Each house is aligned with the angle of a crossbeam in relation to the navigators seat at the stern of the canoe.[20]

The summit of Kahoʻolawe is identified as an ideal location for training navigators because it is the closest landmass to the latitudinal center of the Hawaiian Islands. "A platform has been recently constructed at Lae o Kealaikahiki for the training of new generations in non-instrument navigation."[21] The Hokuleʻa made perfect sense as a precedent for a transportable shelter that needed to be self-sufficient and respond to the regional contexts, particularly the indigenous culture's values.

4.3 TRANSLATION

The next stage in the design process required translating the site contexts, program, design principles, and precedent into a unified solution. The translation process required the biggest jump from theory to application. The design of the CSR-8 made this jump by first identifying applicable components of the precedent then translating them into architectural solutions for creating space.

The number of applicable components from the Hokuleʻa that could ultimately be used architecturally is infinite; therefore, five components were selected. The hull, crossbeams, decking, mast & sails, and system for protection against storms was selected then translated into an architectural use. The following table illustrates the translation of the voyaging canoe components into architectural uses.

[19] Will Kyselka, "The Star Compass," in *The Wayfinding Art: Ocean Voyaging in Ancient Polynesia*, ed. Cary Sneider and Will Kyselka, 23-24 (Berkeley, California: Regents of The University of California, 1986), 23.
[20] Polynesian Voyaging Society, "Star Compass," http://pvs.kcc.hawaii.edu (accessed March 27, 2009).
[21] Davianna McGregor, *Nā Kuaʻāina: Living Hawaiian Culture* (Honolulu, Hawaiʻi: University of Hawaiʻi Press, 2007), 258.

	VOYAGING CANOE COMPONENT	ARCHITECTURAL USE
HULL	• Plank built with structural ribs • Curved for strength and maneuverability • Used for primary storage space	• Exterior structure for open plan • Diagonal elements for increased structural capacity • Storage integrated into the structure
CROSSBEAMS	• Primary structure for holding the major components of the canoe together • Supports the deck, mast, and people	• Large horizontal structural elements • Repeating structural member
DECKING	• Spaced to allow water through relieving pressure from top and bottom	• Ventilation • Water drainage
MAST & SAILS	• Primary energy source • Adjusts to climate conditions by raising and lowering sails • Masts anchored by lines to crossbeams	• Use wind for energy • Make components quickly adjustable • Adjustable enclosure
STORM PROTECTION	• Drop sails, jettison deck shelter, and swamp boat if necessary	• Retractable, closable, or removable components

Although these components could be used architecturally there was no coherence in the design attempts to use these components. The revelation then came to take the voyaging canoe and work backwards from the completed design until it worked on land in accordance with the program and design principles. This decision completed the jump from theory to application. Simply adhering to the precedent allowed the design process to methodologically resolve problems and integrate design principles.

Adhering to the precedent helped to create continuity in the design and avoid a poorly patched together string of ideas. Closely reflecting the characteristics of the precedent gives the CSR-8 authenticity as a culturally inspired design. The Hokule'a represents hundreds of years of refined Hawaiian seafaring heritage. The closer the design adheres to the precedent the better it embodies the cultural values recognized in the precedent. In the case of the CSR-8 it closely adheres to the proportions, structural system, aesthetic, and functions of the Hokule'a. The Hokule'a has eight crossbeams and so does the CSR-8. The CSR-8 use wind similarly to how he Hokule'a uses the wind for energy. The CSR-8 translates many of the components of the Hokule'a to useful architectural elements.

In the design process, adhering to the precedent had the biggest influence on a successful translation. The development of the program, design principles, and evaluation of the site created a holistic guide that lead to the selection of a great precedent. The Hokulea'a is a product of indigenous cultural values that respond to the contexts of the region in a self-sustaining transportable shelter. Recognizing these characteristics of the precedent allowed for a successful design process. The resulting CSR-8 is embedded with the contextual forces of the region, highly sustainable, and appropriately reflects the indigenous culture's values.

4.4 THE CSR-8

The CSR-8 is proportionally similar to the dimensions of the Hokule'a. It is 60 feet long, 18 feet wide, and has two masts each 28 feet high. The CSR-8 uses eight full crossbeams spaced six feet on center mounted with adjustable footings to support a single deck 29 inches above ground level. Along each side of the structure are mounted removable weatherproof storage containers totaling 384 cubic feet of highly accessible storage space. At the front of the CSR-8 is a food preparation space with two sinks, a propane stove, refrigeration unit, and counter space for food preparation and serving.

The primary living space is located on the deck between the two masts. The deck is a multipurpose space that can be used for a variety of purposes. The primary purpose of the deck is for meeting, dining, living, and sleeping with various configurations of shelter to support each respective use. A composting toilet, or something similar, would be properly located on the site to serve users for the duration of the CSR-8's support for a given area.

The CSR-8 is designed as a temporary shelter that can be transported to a given site. The CSR-8 assembles and disassembles with no permanent components, such as a foundation.

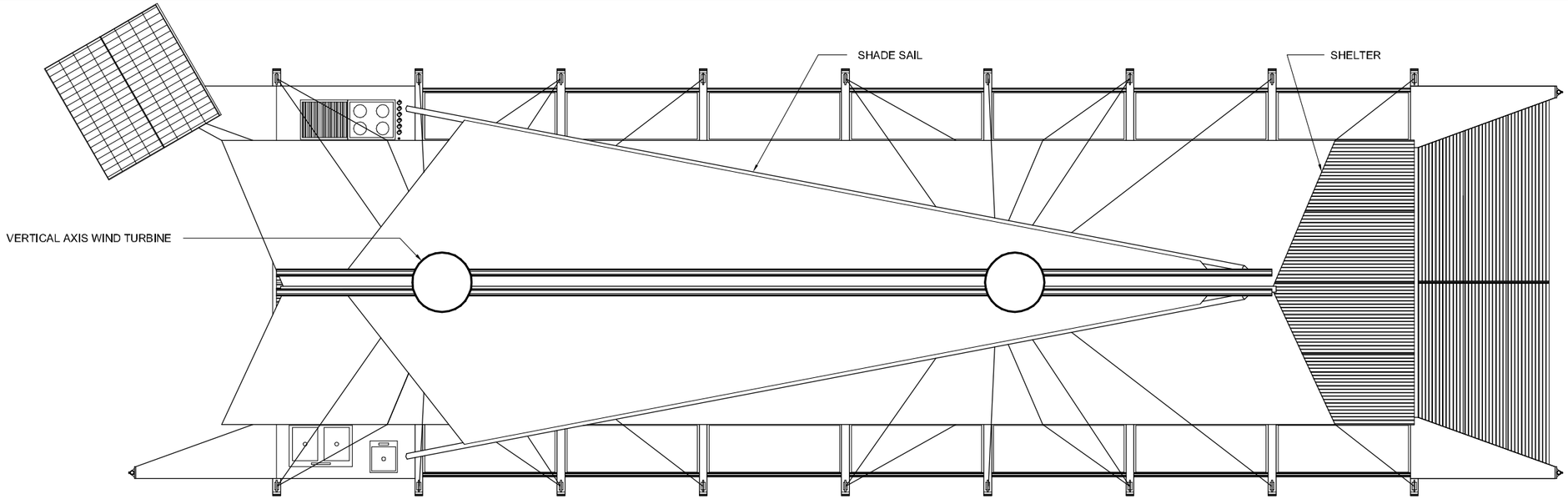
Once the usefulness of the CSR-8 for the restoration or educational needs in an area is complete it can then be quickly disassembled and moved to serve the needs in a new location with no scaring to the land.

Modular components allow the CSR-8 to be movable in manageable sized pieces, quickly assembled on site, expandable, and easily adapted for various needs by the inclusion of specialized modules. The CSR-8 consists of modular pieces that can be easily transported by boat, helicopter, truck, or even by hand with a group of people. All of the pieces are designed so that each module is no heavier than 100-200 lbs so that two people can transport and assemble the CSR-8 by hand.

The 16 storage containers, located along each side of the CSR-8, are made of aluminum and designed to transport supplies as well as store them. The containers are purchased pre-fabricated components produced by ZARGES that integrate well with the overall design. The containers are approximately two feet high and wide with a length of six feet. Ergonomic heavy duty sprung drop handles make the containers easily handled. The containers are water tight and stackable allowing for efficient safe transport by water, land, or air.[22]

The total shipping weight of the CSR-8 is estimated to be 9,500 pounds.[23] The largest single components are the masts at 28 feet long and the turbine towers at 30 feet long. The next largest component are the crossbeams at 18 feet long followed by the decking at 12 feet long. Almost all the components have a thin cross section except for the storage containers, which is only 24 inches. The CSR-8 can easily be shipped in a standard 40-foot cargo container with room to spare. If the masts and towers were separated from the rest of the components, the CSR-8 can be shipped in a standard 20-foot cargo container.

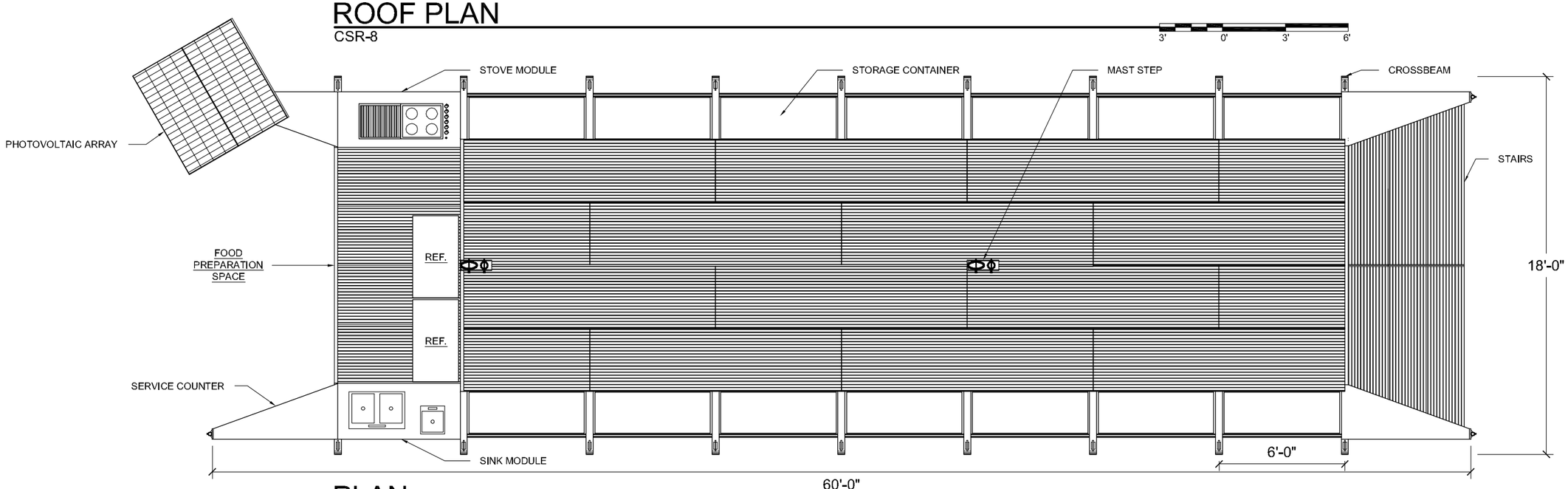
[22] ZARGES, *K 470 Universal Container*, http://www.zarges.com (accessed March 3, 2009).
[23] See Appendix B for weight calculations.



ROOF PLAN

CSR-8

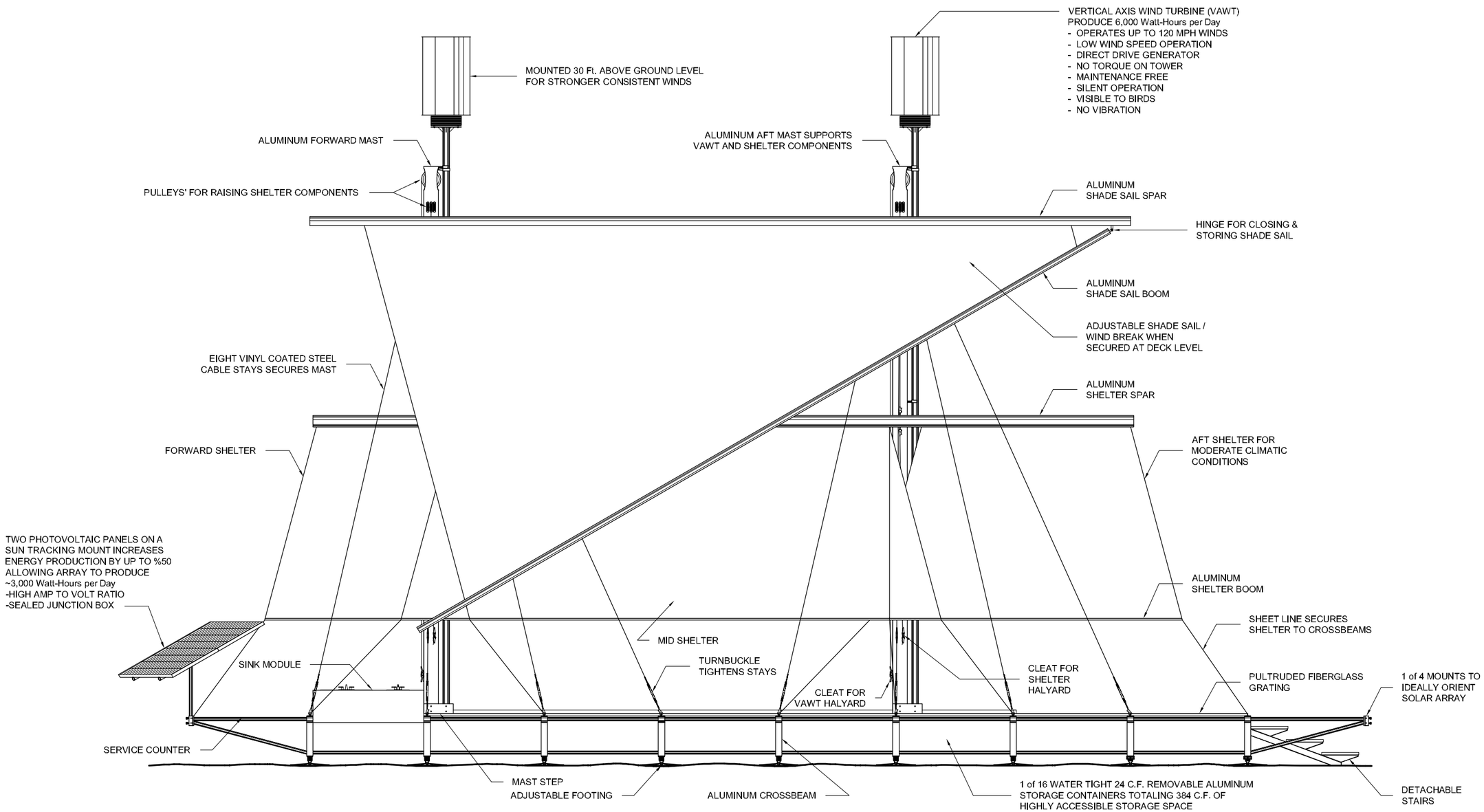
3' 0' 3' 6'



PLAN

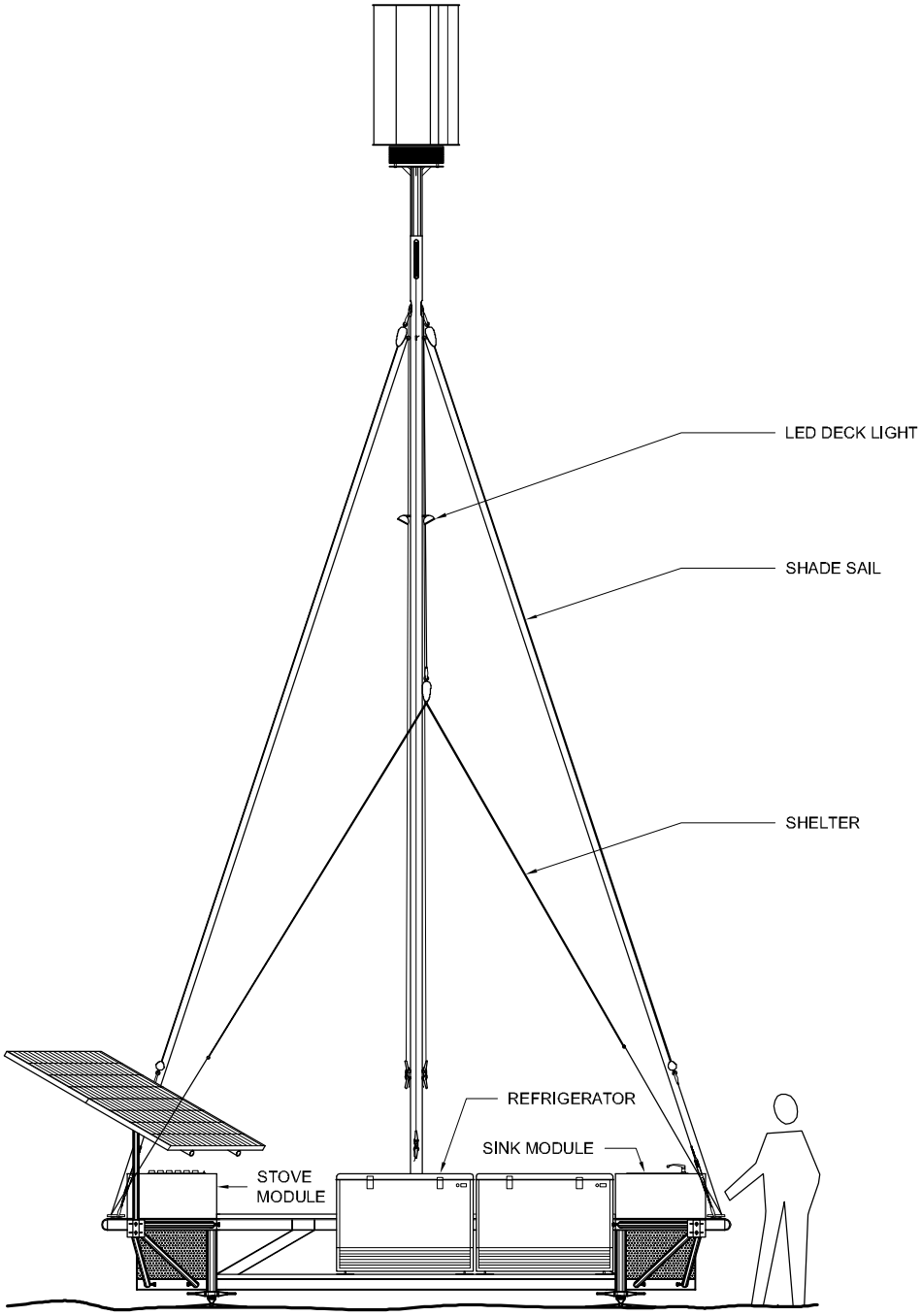
CSR-8

3' 0' 3' 6'



PORT ELEVATION

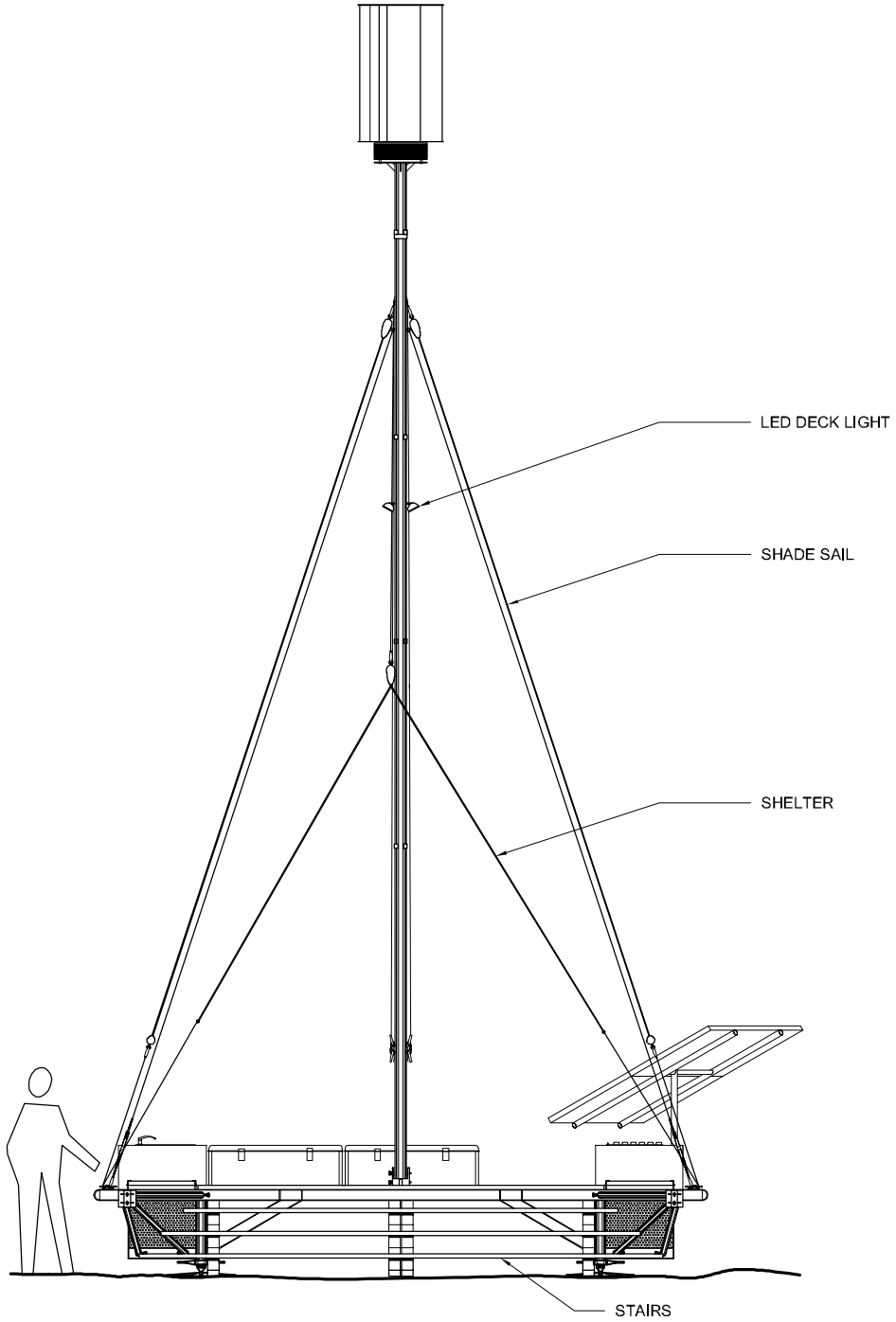
CSR-8



BOW ELEVATION

CSR-8

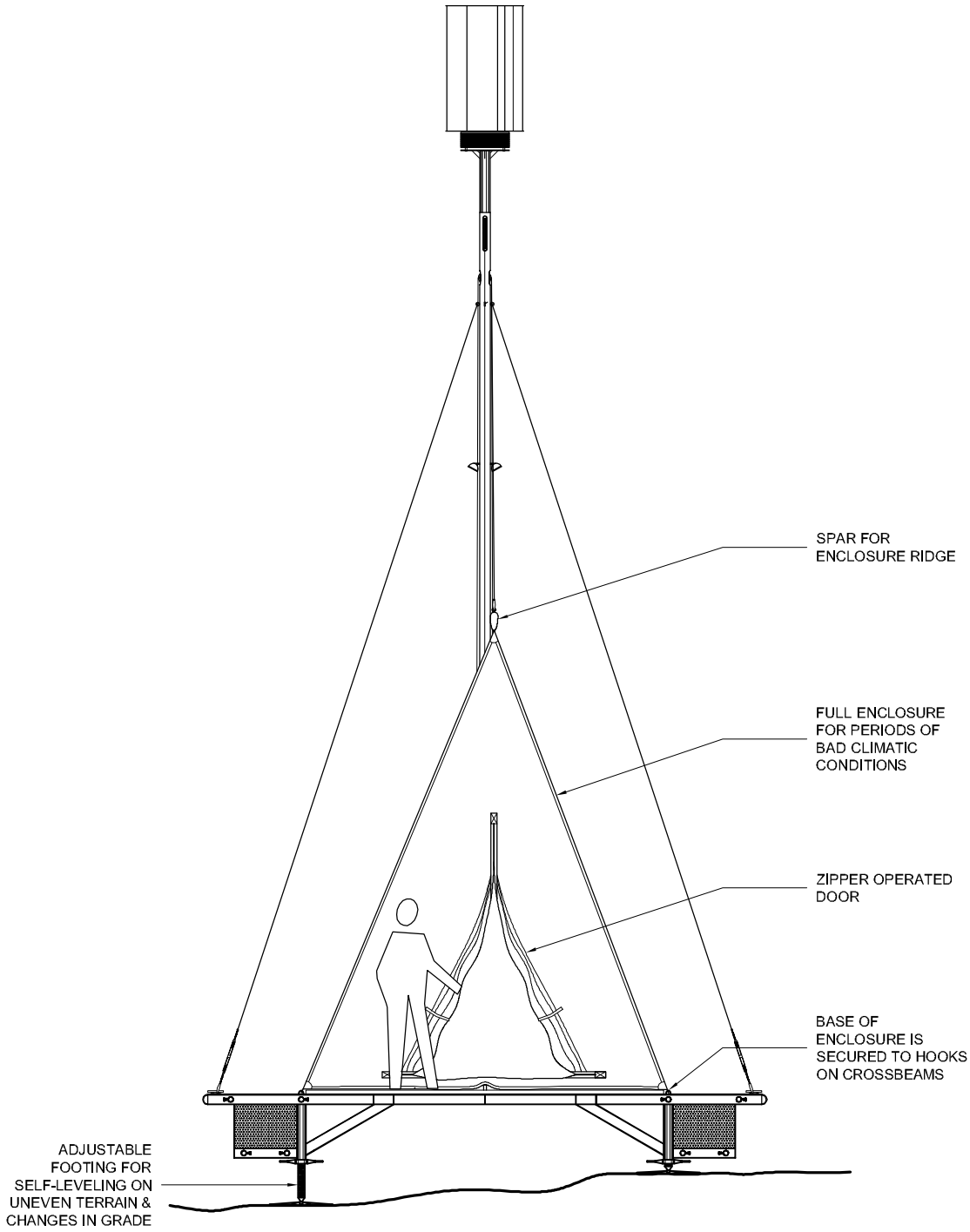
3' 0' 3' 6'



STERN ELEVATION

CSR-8

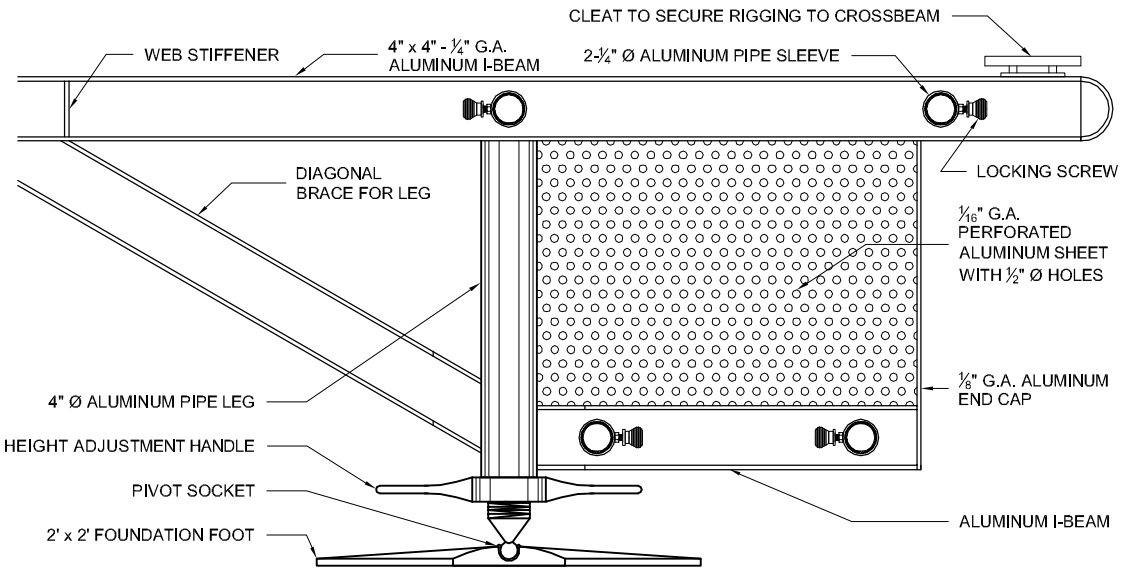
3' 0' 3' 6'



SECTION

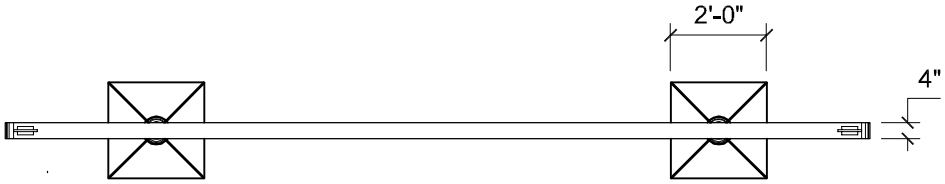
CSR-8

3' 0' 3' 6'



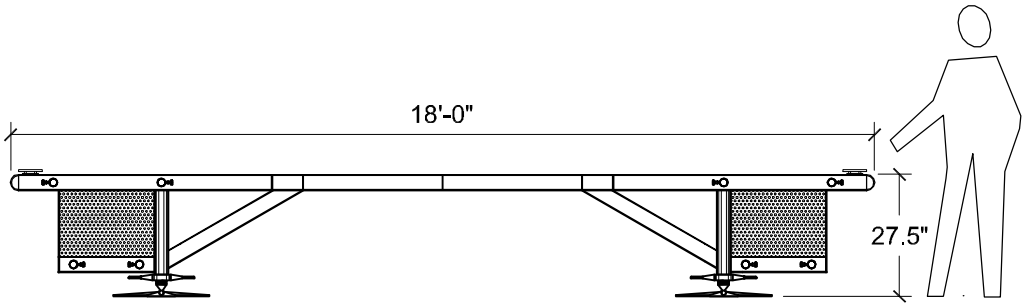
CROSSBEAM - DETAIL

1"=1'-0"



CROSSBEAM - PLAN

1/4"=1'-0"



CROSSBEAM - ELEVATION

1/4"=1'-0"

SITEING

The CSR-8 is designed to assemble in several hours depending on the manpower and available equipment. No tools are needed for assembly as all the components are designed to clip, pin, or lock together. The CSR-8 is designed to accommodate sites with moderate changes in grade up to a two-foot change in elevation across the width of the shelter. For sites with a grade of more than seven percent, a footing extension can be added to give the CSR-8 longer footings where needed. Footing extensions for a variable grade will require railing protection for a significant topographic drop. Each of the sixteen adjustable footings has large square footing pads that can pivot to sit properly on uneven or sloping terrain. This prevents the need for grading a site thus minimizing the impact on the land. Mouse guards are included around the legs of the footings.

Ballast should be placed around each footing to prevent the CSR-8 from overturning. A number of things can be used for ballast around the footings such as rock, sand, or even water with the use of a suitable bladder-like container. The site will determine which source is most abundant. In the case of Lua Makika sand bags are the easiest method to provide ballast for the footings.

Siteing and orientation play an important role in the in the assembly process. In most instances the terrain will determine the CSR-8's orientation. The exact location of the CSR-8 should avoid impacting natural and cultural objects such as flora or historic sites. Whenever possible the CSR-8 should be oriented perpendicular to the sun and wind direction. If the sun and wind directions are dissimilar a compromise orientation should be selected. Orienting the CSR-8 perpendicular to the sun and wind direction allow shading and wind breaks to provide the most consistent protection.

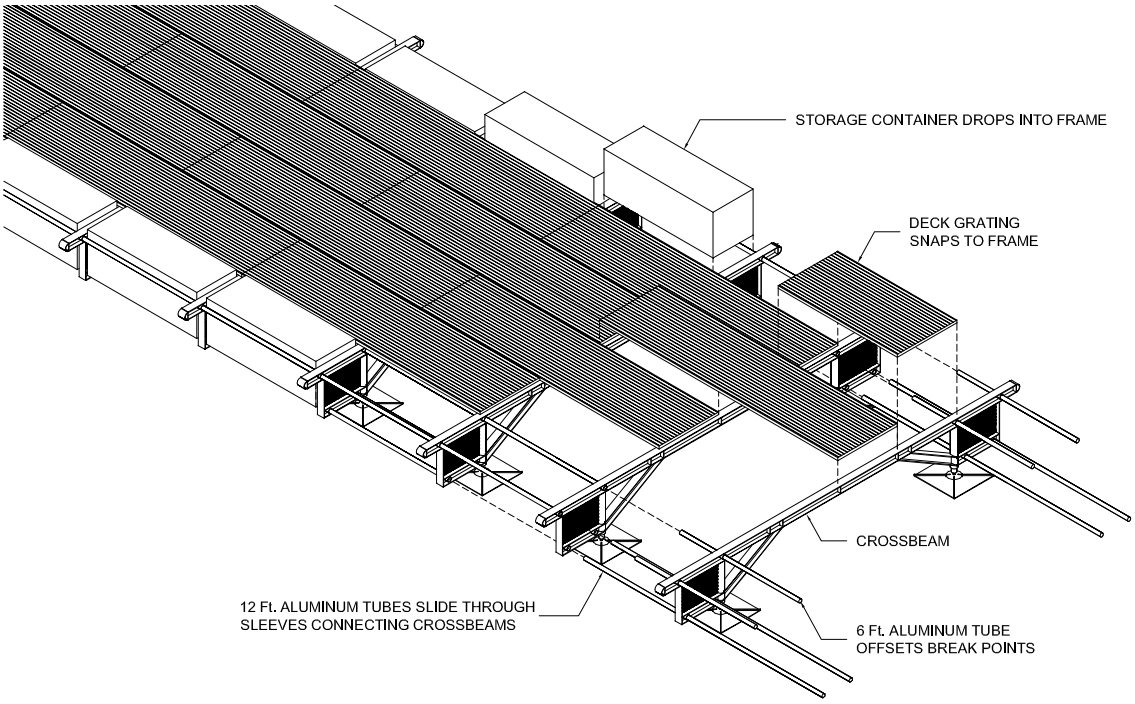


Figure 4.7 CSR-8 Frame Assembly Diagram

STRUCTURAL FRAME

Once a site and orientation is selected the eight crossbeams should be approximately placed every six feet in a row. Starting from either end of the CSR-8 the crossbeams are connected by aluminum tubes slid though the pipe sleeves fabricated into the crossbeams. Each aluminum tube is 12 feet long in order to increase strength by connecting three crossbeams with a single structural member. There are several six-foot lengths of aluminum tube designed to offset the break points so that every crossbeam has at least four continuous structural members out of the eight. This creates a stronger structural system. As the aluminum tubes are inserted the crossbeams should be positioned according to pre-marked indicators on the tubes for proper spacing. Once properly aligned a locking screw on each of the pipe sleeves can then be hand tightened to secure the system in place. Once all the crossbeams are secured there are four end structures that cap the structural system at the front and rear of the CSR-8.

DECK

Once the crossbeams and frame are assembled and held down by ballast the deck system can be assembled. The first piece is the longitudinal beam that lies across the crossbeams and clamps to the flanges of the aluminum I-beam that makes up the crossbeams. This beam distributes the weight of the masts and provides a track on which the masts can be moved to different configurations. This beam lies across all but two of the end crossbeams because the masts are positioned towards the front of the CSR-8 leaving the back open for meeting space. As soon as the longitudinal beam is in place the decking can be laid down. The decking is clipped down with pre-installed spring clips on the crossbeams. The deck system is staggered so that seams are offset creating a strong system. With the deck in place the storage containers can be dropped in place along the side of the CSR-8.

MASTS

The masts are the next components to be assembled. The first task is locating and placing the mast steps on the longitudinal beam. The standard setup has the forward mast located on the first crossbeam and the aft mast located on the fifth crossbeam. The mast steps should be pinned in place on the longitudinal beam before raising the masts. The forward mast must be raised first by laying it on the deck and pinning the base with one of the two pins in the mast step. Rotate the mast up perpendicular to the deck within the mast step using the stays and shrouds. To secure the mast vertically, place the other pin through the mast in the mast step and clip the turnbuckles to the cleats at the end of each crossbeam. The rigging is tensioned using the turnbuckle fixed at the end of each line.

Before repeating the setup process for the aft mast the forward wind turbine needs to be installed. The wind turbine cage must be attached to the generator and mounted to its tilt-up tower. Two high intensity LED lights for either side of the deck are also mounted to the tilt-up tower. The tower base is then pinned in the mast step. The wind turbine is

then tilted up parallel to the mast using the halyard line running from the top of the mast. Located every six feet along the mast are spring clips that hold the tower in place. The halyard line is secured to a cleat on the mast preventing the tower from moving. The same process is repeated for the aft mast and wind turbine.

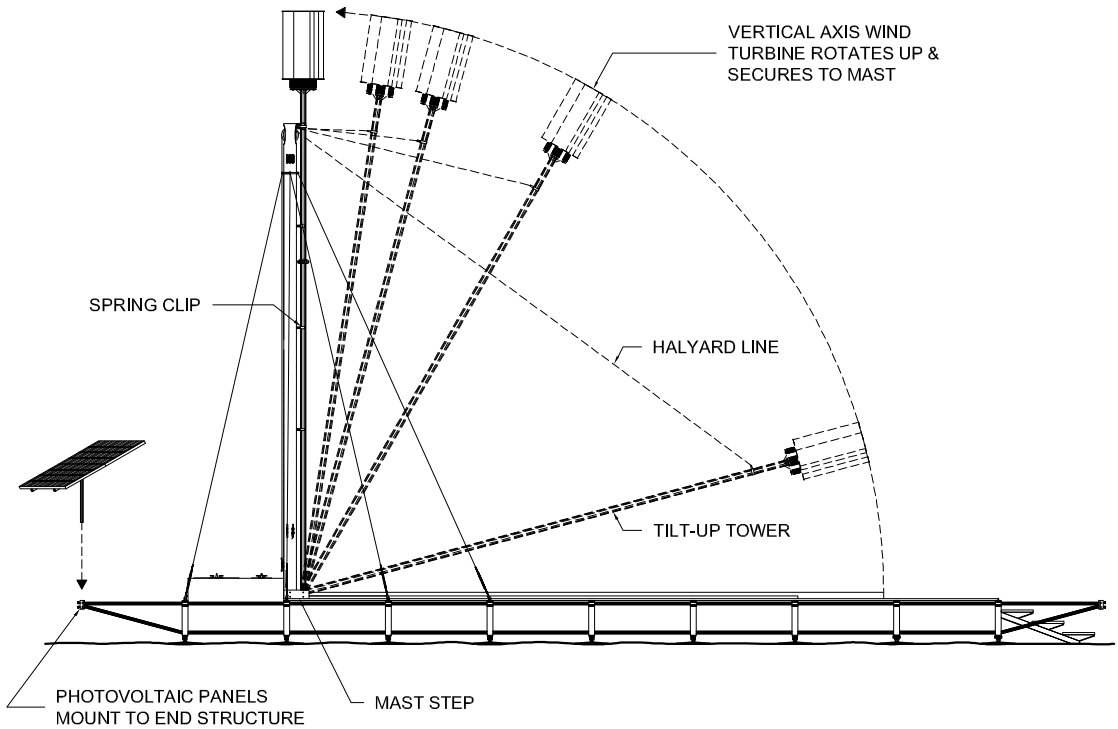


Figure 4.8 VAWT Assembly Diagram

The final structural piece to be assembled is the shelter spar. This is a two-piece tubular beam that supports the ridge of the shelter systems. The two pieces of the spar lock together to form a 42-foot piece. The spar is then attached to halyard lines on the masts and raised up remaining parallel to the deck until needed.

ENERGY SYSTEM

With the entire structural system in place the support systems can be assembled. The support systems include energy, water, and shelter. The energy system is primarily electrical with the use of propane for cooking. The lights and wind turbines were

assembled with the masts. A small photovoltaic array using three panels is attached to a sun-tracking mount. The sun-tracker is fixed to a pole that fits into sleeves located on the four end structures. The array should be located at the corner of the CSR-8 that is facing the sun path. Power cables are pre-installed in the tilt-up towers for the wind turbines and lighting. The cabling is a plug and play system that requires no wiring skill. All the cabling runs underneath the deck hung from hangers to a central power control box. The central control box, that contains the batteries and power controllers, is hung from the crossbeams under the forward mast. Due to the weight of the batteries the control box may need to have the batteries placed in it and plugged in after transportation. As each electrical component is installed it gets plugged into the control box.

The electrical and water systems primarily support the food preparation space at the front of the CSR-8. A module with sinks is dropped into one side of the structure and a module for the propane stoves on the other side. The module for the sinks contains a pump, filter, drainage system, and 150-gallon tank. One of the cables from the control box plugs into this module. The Module for the stove contains the burners, two 25lb propane tanks, and storage for cooking utensils. This module requires no further connections. Located within the food preparation space are two eight cubic foot refrigerator/freezers. These get plugged into the control box.

The water system consists of collection/production, storage, distribution, and drainage. The only assembly required is connecting the various components with flexible tubing. Gutters are integrated into the booms of the various shelter components. At the end of the gutters are clear flexible tubing downspouts where rainwater is channeled into storage tanks. The production and use of water is explained in further detail later. Assembly is complete once the service systems are in place. A shelter configuration suited for the current conditions and user needs can now be deployed.

The shelter enclosures of the CSR-8 make it highly adaptable. Adaptability is achieved in the various levels of shelter provided by the use of adjustable coverings and enclosures. Most of the time there is only need for shade from the sun and shelter from the occasional afternoon rain. In other conditions the need may be for shelter from strong winds or there might be a need for complete protection and shelter from an intense storm. With the incorporation of a quick and easily adjustable system of shelter the CSR-8 effectively serves the needs of its users while maintaining a strong connection to the land.

Moderate Climate Shelter **Two Wind Breaks** **One Shade Sail & Wind Break**

Figure 4.9 Shelter Configurations[24]

The CSR-8 is designed to respond to three main environmental conditions: Good, Moderate, and Bad. Each of these environmental conditions represents a noticeable change that requires an adjustment in shelter to maintain comfort and/or safety. The following assumptions define the three conditions:

Environmental Condition	Sky	Rain	Wind (mph)	Temperature (Low/High) °F	Rodents & Insects
Good	Clear	—	1-9	75/80	—
Moderate	Partly Cloudy	Intermittent	10-20	70/85	Apparent
Bad	Cloudy	Consistent	20+	60/90	Infestation

The CSR-8 provides various shelter configurations for the three weather conditions day or night. For good weather the CSR-8 provides shade during the day when people are using the structure, which is provided by the large triangular sails that can be adjusted as the direction of sunlight changes. The sail spars are raised on the outside of the mast rigging using halyard lines. The booms of the shade sails are secured to the crossbeams

[24] See Appendix A for shelter configurations.

below by the sheet lines. During the evening and night the sails can be let down for stargazing and an open setting.

For moderate weather conditions, depending on the need, several different configurations of enclosure can be quickly erected on the main deck. Three different sections of cover can be attached to the shelter spar, raised, and secured on two sides of the deck to provide protection from moderate winds and rain. This is open on two ends and uses the structures pultruded fiberglass grate as the flooring. For a fuller enclosure a different system is deployed, which is closed on the ends and floor.

The full enclosure is much like a traditional tent. The floor gets secured to the deck at each cross beam spanning from side to side and mast to mast. The roof/walls are then secured to the boom and raised. This provides quick full enclosure from all sides top and bottom. If insects or rodents are the only issue an enclosure made entirely of mesh can be used instead, making the space much more open and ventilated.

The full enclosure is opaque, water resistant, and wind resistant. There are no polls or ridged structure to install because the masts, deck, and shelter spar provide the structural support. The doors are openings that can be opened or closed by zippers from the inside and outside. Additionally, screen material creates a second set of zippered doors to protect against insects and rodents. The enclosure material is made of Gortex to provide water and wind protection on the exterior and ventilation on the interior.

For the infrequent periods of bad weather the full enclosure openings are closed and the spar lowered to create a thin profile significantly reducing wind force against the enclosure. This is not conducive to living space but does provide protection to people from brief periods of extreme and harsh weather conditions that may arise.

Enclosures for changing or washing can either be located on the sides of the masts or at the aft end structures. This consists of a rectangular curtain secured at the bottom and raised from the top. The enclosure systems are designed to quickly assemble and disassemble allowing the CSR-8 to respond to the environment. Included with the CSR-8's response to the environment is its self-sustaining renewable energy system. Power used by the CSR-8 is maximized for efficiency. The system is designed to effectively produce more energy than it consumes. The CSR-8 is designed to work with a community of structures and systems if needed. Propane stovetop burners for cooking and extremely efficient direct current (DC) powered refrigeration units reduce the larger power demands. This frees up power for use in water production or equipment for restoration activities.

To limit complexity and set up time only four LED deck lights are used for lighting, two on each wind turbine tower. This provides the flexibility of four different lighting areas. A VHF radio for communications and pump for water used in cooking, hand washing, and possible bathing is included in the energy needs.

The energy system is designed to operate primarily on DC 12 volt power, which is more efficient than alternating current (AC) based systems especially when using wind & solar power supplies. A small inverter is needed for personal devices and power tools.

Energy is produced from a hybrid system of Vertical Axis Wind Turbines (VAWT) and photovoltaic panels. The energy produced is stored in four 6-volt batteries along with the controllers and inverter hung underneath the structure in an appropriate weatherproof enclosure. To keep the structure transportable the batteries and system has been selected based on the weight of a limited number of pieces that are preconfigured to quickly connect and disconnect. The system is broken down into less than twenty transportable components with the heaviest individual component weighing 140lbs (refrigerator).

Component	#	Description of individual components to be transported
Wind Turbines	6	Two wind turbines each with (1) cage, (1) generator, and (1) tower
Photovoltaic Array	4	(3) panels and (1) mount
Controllers / Inverter	1	Mounted in (1) power control box
Batteries	4	(4) batteries weighing 69lbs each
Lights & Cabling	1	Transported in (1) storage container
Pump	1	Pre-mounted in (1) sink module
Refrigeration Units	2	(2) refrigeration units 140lbs each
Total	**19**	

The CSR-8 uses two PacWind SeaHawk series VAWT's. The SeaHawk has a very low wind speed operation with a cut in speed of only 7 mph and no cut out speed. The SeaHawk is virtually silent during operation, maintenance free, and visible to birds. The SeaHawk is designed for maritime applications and because it is a VAWT it has no blade sweep area and does not vibrate or apply any bending moment on the tower during normal operation. The SeaHawk is only 48 inches high and 30 inches wide giving it a minimal profile and making it easily transported.[25] It is mounted to a tower it that is 30 feet high, ideally placing it several feet above the masts and in stronger winds.

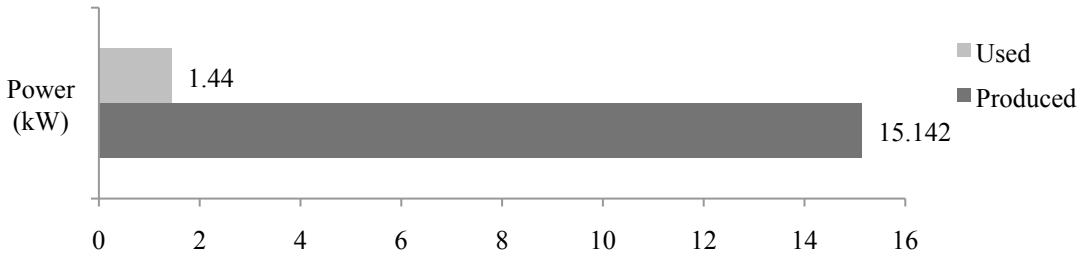
The wind measurements taken over a ten year period near Lua Makika suggested ideal conditions for wind power. The constant wind average, which is the average wind speed over a twenty-four hour period sample for at least a year, is 15.9 mph. Using this data one of the SeaHawks mounted on the CSR-8 can produce 6,000-Watt-Hours per day (Wh/day). Unlike typical wind turbines that use a gearbox, the SeaHawk is directly connected to the generator. This allows the SeaHawk to continue to produce power in wind speeds up to 120 mph, which is equivalent to a Category III Hurricane. Conveniently, the SeaHawk controller is designed to integrate with a photovoltaic array for a more reliable hybrid power production system.

The CSR-8 eight uses two Evergreen ES-A-210 photovoltaic panels. These panels have a high amp to volt ratio giving them optimum voltage for battery charging. The panels

[25] PacWind, Inc., *SeaHawk*, http://www.pacwind.net (accessed March 12, 2009).

have a sealed junction box that never needs maintenance making them ideal for remote off-grid systems such as the CSR-8. The panels are mounted to a Wattsun Active Tracker increasing the arrays power production by up to 50 percent. This system is estimated to make up to 3,000 Wh/day at Lua Makika.

The total power required by the CSR-8 for operation is only 1,400 Wh/day. The total power being produced is over 15,000 Wh/day.[26]



The abundance in power production allows the CSR-8 to distribute power for other needs in the area or even run an atmospheric water generator. The only set back to being able to produce a sizable amount of power is the space needed to store that power. The design only uses four 69 lb. batteries, which is enough storage capacity for three days without power production given the amount of power required for operation. The CSR-8 is capable of holding a large battery bank but the larger the battery bank the harder it is to transport and assemble. The CSR-8's exceptional power production creates the possibility of supporting or plugging into future renewable power systems that may be installed around Kaho'olawe.

The CSR-8 uses water based on the amount available. In the most extreme situation, there would only be enough water for minimal needs such as drinking and cooking. At the other end of that spectrum water could be abundant allowing for showers, surface cleaning, and other luxuries. It is estimated the water needed to support twenty people each day could be as low as 40 gallons to as high as 300 gallons. Potable water is needed

[26] See Appendix C for energy calculations.

for drinking, washing (hands, face, and brushing teeth), first aid, cooking, and dishwashing. The sink module located in the front of the CSR-8 provides potable water. With sufficient water supplies further water use includes near potable water for showers, clothes washing, and water for cleaning the CSR-8 and other tools.

Water at Lua Makika can be obtained in a number of ways. The best method is rainwater catchment. Over 25 inches of rain falls on average each year near the summit at Lua Makika.[27] This is more than enough water to support twenty people for four day durations. Using this method a bladder tank would be laid underneath the CSR-8 to provide enough storage capacity. Additionally, the bladder tank could be used for ballast instead of sandbags if lines were strung under the tank before it was filled and attached to the CSR-8. However, the tank could never drop below half capacity to avoid a loss in required ballast. Using polyurethane tanks located near the CSR-8 or even filling the water tight storage containers could supplement as alternate means of water storage. The storage containers are designed to hold up to 180 gallons of water each. The booms on the shade sails are designed to function as gutters that channel rainwater from the sails to clear flexible tubing that gets connected to a storage system. The use of rainwater catchment would need to be supplemented by another water source until sufficient rain could fill the storage tanks.

Another method for obtaining water would be simply to fill the storage tanks on the CSR-8 with water transported in a tank on a truck each time a group of volunteers arrive. Depending on the CSR-8's location to the large storage tanks already implemented in the restoration area, a supply hose could be run from the tanks to supply water to the CSR-8. The final method of water production would be the use of an atmospheric water generator that would be capable of producing up to ten gallons of potable drinking water per day. The only draw back to this method is the high amount of energy the atmospheric water

[27] Kaho'olawe Island Reserve Commission, *Kaho'olawe*, http://kahoolawe.hawaii.gov (accessed March 25, 2009).

generator consumes. The current power production of the CSR-8 could support running an atmospheric generator for the three days each week volunteers are not using the shelter. This would provide 15 gallons of fresh drinking water ready for use when volunteers arrive. Ultimately, the method of supplying water will need to be determined by the amount needed and the rainfall data.

The CSR-8 is made from a variety of materials and components designed to meet the functional characteristics intended. The CSR-8 requires very little maintenance because of the materials selected and the design. The entire structural frame is made from pre-fabricated aluminum components that include the crossbeams, tubes, end structures, and masts. Aluminum is abundant, 100 percent recyclable, it has a high strength to weight ratio, and it is very corrosion resistant. To increase the life cycle of the structure and reduce heat conduction, all of the aluminum components are powder coated white. Powder coating is a painting method that electrostatically charges powder particles to adhere it to metal then melt it on in a baking process. Powder coating offers superior scratch resistance, chemical resistance, and impact resistance. More importantly powder coating is an environmentally friendly process that does not use any volatile organic compounds (VOC's) and can retrieve and use overspray thus eliminating waste.[28]

The decking is made of pultruded fiberglass Aqua Grate® Pedestrian grating. This grating has an incredible strength to weight ratio and can free span over six feet with a thickness of only an inch and a half. Pultruded fiberglass grating is corrosion resistant, non-conductive, long life, and low maintenance. Using this material makes the CSR-8 transportable, easily maintained, and provides a cool surface to walk on. The Aqua Grate® is designed to offer optimum comfort and safety for bare-foot use. The grating reduces uplift while providing ventilation, allows water to drain, and dirt to be quickly swept through the spaces.

[28] Sunset Powder Coating, *Powder Coating*, http://e-siteworks.com/sunsetpowdercoa (accessed March 17, 2009).

The rigging lines are vinyl-coated steel cables and the halyards are braided nylon with a high resistance to ultra-violet degradation, water, and abrasion. Electrical cabling is pre-run through flexible conduit, for protection from mice, at the appropriate lengths with quick release plugs at each end. The refrigerators are contained in weatherproof enclosures that shield them from the elements, provide ventilation for the compressors, and have handles for transportability. The top of the storage containers, when closed, provides counter space for food preparation as well as the top of each end structure. The shade sails are made of canvas and the shelter of Gortex. The stove and sink modules are mostly aluminum with hinged covers to protect the equipment when not in use. The storage containers are doubled hinged to allow access from the upper deck or ground side. Pneumatic gas shocks hold the lid open for safe easy access. The lids of the storage containers can be completely removed for unobstructed access for larger objects.

The CSR-8 can respond to a wide range of environmental conditions and terrain. The CSR-8 can even be reduced or expanded depending on the need, giving it superior adaptability. The CSR-8 is designed with eight full crossbeams and two masts but variations on the model could use only four crossbeams and one mast. The CSR-8 module easily expands by continuing the system from the rear and placing another food preparation space at the end reflecting the front space. This would double the capacity of the CSR-8.

Finally, the CSR-8 is cost effective estimated at $70,000 to $90,000.[29] The $90,000 cost estimate is based using the best materials and maximum production capability. By reducing the production capacity of the CSR-8 and still maintaining a self-sustaining system the cost estimate is approximately $70,000. The cost could be reduced further to $50,000 but this would require a change in materials and impact the sustainability and

[29] See Appendix D for cost estimating.

transportability of the CSR-8. This discussion of the CSR-8 describes the option using the $90,000 cost estimate.

Although the structure is only 1,000 square feet, it is highly productive and useful. The transportability of the CSR-8 allows it to continue effectively supporting restoration and educational needs around the island greatly increasing its useful life span. The design of the CSR-8 eliminates costs associated with site grading, infrastructure, construction, and maintenance. Most importantly, the CSR-8 has a high return on investment (ROI). The power and water production alone gives the CSR-8 a payback of only a few years but when one considers the costs saved by being able to relocate the structure it trumps any permanent buildings ROI.

4.5 CONCLUSION

The CSR-8 is a unique design that captures the qualities of culture, sustainability, and regionalism. The purpose of the CSR-8 is to demonstrate the applicability of a regional design methodology, with a focus on sustainability and culture, for producing architecture appropriate to place. To validate that the CSR-8 accomplishes its purpose the design is evaluated on its regional qualities, sustainability, and cultural integration.

Regionalism is a holistic design method that strives to counter the placelessness and lack of meaning in Modern Architecture by using the contextual forces of a given place as inspiration. Regionalism essentially addresses everything including sustainability and cultural contexts. However, as this research has argued, Regionalism can be improved with a stronger focus on the contexts of sustainability and culture. The resulting hybrid design methodology is referred to as Culturally Sustainable Regionalism.

The CSR-8 is the product of applying Culturally Sustainable Regionalism. The design process previously discussed shows the holistic approach taken, with focuses on culture and sustainability, in order to create meaningful place specific architecture. Regionalism strongly emphasizes an ability to associate a building with the place in which it is built. The CSR-8 captures that associative quality in aesthetics, functionality, and materiality.

Aesthetically, the CSR-8 reflects the maritime qualities of the island region by its use of large sails raised on masts held in place by lines. The strong geometric shapes are contrasted by the delicate details of stays and halyards crisscrossing. The proportions and massing are similar to that of the traditional voyaging canoes that are a symbol of the regions identity. The structure is light in appearance and blurs the lines between open and enclosed space, roof and walls. The numerous footings are designed to adapt the structure to the terrain giving it the appearance of floating over the land. Aesthetically the CSR-8 communicates a tropical environment with its openness and steep overhanging covering. The thin massing further supports a visual understanding of the environmental conditions that suggests a warm climate with few harsh extremes in temperature differences. The triangular geometries created by various aspects of the CSR-8 reflect the indigenous cultures geometric patterns and artistry. Aesthetically, the design is unmistakably associated with the qualities of the Hawaiian region.

Functionally, the CSR-8 can be associated with the region through its interaction with the environment. The design is open and connected to the landscape. The structure is not designed to permanently live in, detached from the land, but to shelter users from the infrequent periods of uncomfortable or dangerous climatic conditions. The open design clearly communicates an interaction with the landscape, not isolation from it.

Specifically associating the CSR-8's functionality with its site Lua Makiaka on Kaho'olawe allows the design to serve restoration efforts. The structure identifies with

the impacts on the land and the efforts to restore it by proving the necessary shelter, storage, power, and water. The region is in repair and the CSR-8's functionality communicates that through its transportability, adaptability, and light impact on the land. The CSR-8 even provides the opportunity for supporting navigational training by its similar layout and proportions to the voyaging canoe Hokule'a.

Materially, the CSR-8 reflects the regions isolation in terms of its modern use of transported materials. The materials represent recognition of the value of available resources by choosing materials with long life cycles. The region has few building materials in abundance; therefore, most materials have to be imported from another region. This creates an opportunity to choose the materials that will best suit the needs of the design as opposed to trying to make a material of abundance work. The use of imported materials is an identifiable quality of the region.

The CSR-8 makes use of the sand and rock available on Kaho'olawe for ballast around the footings. These are the only naturally available building materials on island and concrete is the only other locally available building material; therefore, the rest is imported from other regions. This is an important reflection of the region because architecture in continental regions that has access to a number of building materials will use that resource. This shapes the identity of that region. Island regions develop a different identity based on how the materials are used not so much on where they are from. Island resources come more in the form of energy from the sun, wind, and ocean as opposed to building materials.

The basic quality of region association is creatively communicated by the CSR-8. The design also maintains the increased focus on sustainable aspects supported by the hybrid design methodology. Sustainability is achieved in many ways but not more so than by responding to and working with the surrounding environment. A temporary transportable

structure that can adapt to various locations is essential for the effective sustainable use of limited economic, material, and human resources on Kaho'olawe. The CSR-8 recognizes this through its ability to be transported, adapt to a site, and self-sustain.

A transportable structure is much more sustainable in terms of responsible use of resources. Transportability maximizes the use of a structure by allowing it to provide services to not just one area but countless areas. The investment, materials, and energy consumed to produce one CSR-8 can be used to support a variety of needs in multiple locations over many years. This significantly increases the useful life span of the CSR-8 because once it serves the needs for a specific area it can then be relocated to serve the needs of a new location. The CSR-8 does not have to be demolished when its use in an area is complete nor does more money need to be invested in materials and energy to build one in a new location. The investment in two CSR-8's would increase the sustainable capacity to meet the needs of multiple locations at the same time.

Transportability also reduces the impact of the CSR-8 on a site. Instead of grading, permanent foundations, and infrastructure that scares the land the CSR-8 is designed to be temporary with self-contained systems that adapt to the site.

Adaptability further adds to the sustainability of the CSR-8 by increasing its usefulness. The design is not a ridged fixed layout that is only conducive to a minimal number of specific uses. The CSR-8 is a shelter that can be used for any number of uses from supporting volunteers for restoration to educational support and a range of uses in between. The size and enclosure of space can be adapted to suit the needs of its users in respect to the environmental conditions. The CSR-8 is a modular system that allows for quick easy alterations to various components allowing it to accommodate specialized needs. The ability to adapt allows the CSR-8 to change to unseen future needs that may arise.

The ability of the CSR-8 to be transported and adapt is achieved not just in its design but use of materials. The entire structural frame and storage containers are aluminum making it 100 percent recyclable and the decking is an extremely durable long life fiberglass. These materials have a high strength to weight ratio giving the CSR-8 its ability to be easily transported.

The CSR-8 works with the surrounding environment. All the energy needs except propane for cooking are provided through rapidly renewable alternative energy sources. The CSR-8 uses a hybrid energy production system that safely converts solar energy to power using wind turbines and photovoltaic panels. The design uses high-energy efficient appliances and equipment. The structure goes beyond the efficient notion of self-sustaining and achieves an effective sustainability by producing.

The CSR-8 recognizes the waste of energy, water, and other resources that results in the necessary contingencies of a self-supporting design. It responds by being able to readily integrate into a community of structures. It produces useful power and water that can be used to support needs outside of its own requirements.

Probably the most sustainable design strategy of the CSR-8 is its integration of cultural values. The CSR-8 integrates the indigenous culture's values of the land, ocean, and surrounding environment helping the community identify with the structure. A building that the surrounding culture can identify with garners care and maintenance thus increasing the buildings life span and therefore sustainability. Although the CSR-8 does not require much maintenance, the more it is valued by its users the longer it lasts.

Cultural integration is important to successful appropriate architectural design. Successfully integrating cultural values is a challenging component in design. Cultural values are the non-quantifiable meanings associated with objects, events, and people.

Integrating these values requires identifying what they mean and what they are traditionally associated with. One of the prominent Hawaiian cultural values is life associated with the land, ocean, and natural environment. The environment is associated with the ability to sustain life and as a result is considered something precious and sacred.

The CSR-8 integrates Hawaiian cultural values by its respect and relationship to the land as well as its association with the values instilled on the Hokule'a voyaging canoe.

By using the Hokule'a as a precedent and adhering to its characteristics many of the values represented in the canoe can be associated with the CSR-8. There is an important distinction between association and replication. The CSR-8 is careful not to falsely represent cultural values through inauthentic copies of traditional structures. The CSR-8 reinterprets cultural values into a new structure addressing modern materials and technology. The CSR-8 does not mimic or copy the Hokule'a but interprets its proven strategies and qualities to create a new functional structure.

The CSR-8 is aligned with the Hawaiian cultural values but it ultimately takes the acceptance and transfer of place by the people to achieve full cultural integration. An object or building has to be given meaning by the culture. The meaning associated with a building is directly tied to what it does or represents. The voyaging canoe represents the founding of the Hawaiian Islands and with it the great seafaring accomplishments of the indigenous culture's ancestors. The CSR-8 does not represent anything until the culture gives it a meaning. However, it does integrate the values of the culture and it does support the restoration efforts of the land.

Integrating culture in architecture is not about falsely attaching meaning to a building but designing that building to support the values of the culture. The CSR-8 supports the Hawaiian culture's value of the land and traditions by its light impact on the land, open

design, and use of seafaring strategies. The design is directly inspired by the indigenous cultural values. It looks to the past in preparation for the future.

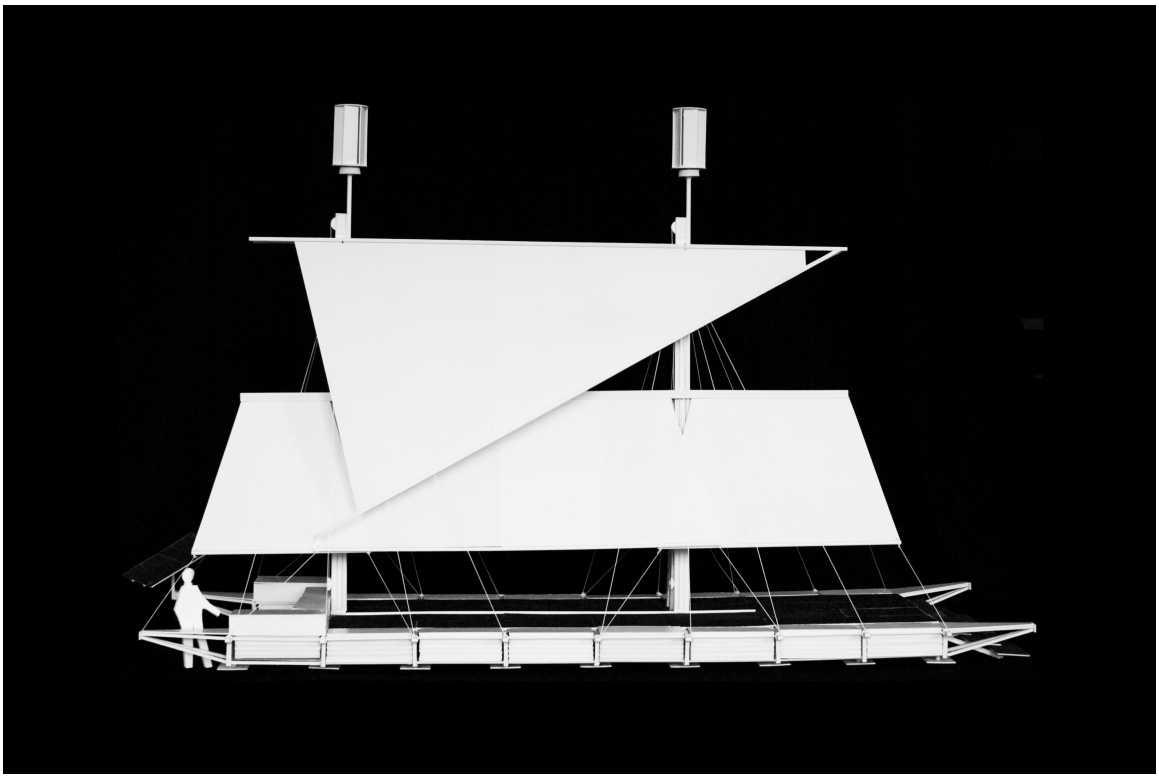
The CSR-8 is a good prototype demonstrating the design methodology of Culturally Sustainable Regionalism. The design is a holistic approach addressing many of contextual forces of Kaho'olawe. The CSR-8 and the design methodology of Culturally Sustainable Regionalism are not limited to Kaho'olawe and the Hawaiian region. The CSR-8 has many applications for regions around the world and specifically Small Island Developing States dependant on their marine resources for the sustainable livelihoods of coastal communities. The design is renewable, responsive, connected, transportable, and integrated with a culture of exploration. The CSR-8 has great potential for voyaging to different sites and regions to provide the shelter, energy, and water needs of an area.

More applicable is the design methodology demonstrated by the CSR-8. It proved the ability of a holistic design approach with a focus on culture and sustainability to create appropriate place specific sustainable architecture. This hybrid design method has great potential for specifically addressing architecture in culturally sensitive areas. It provides a system for adequately addressing the contextual forces of a site and translating them into a design.

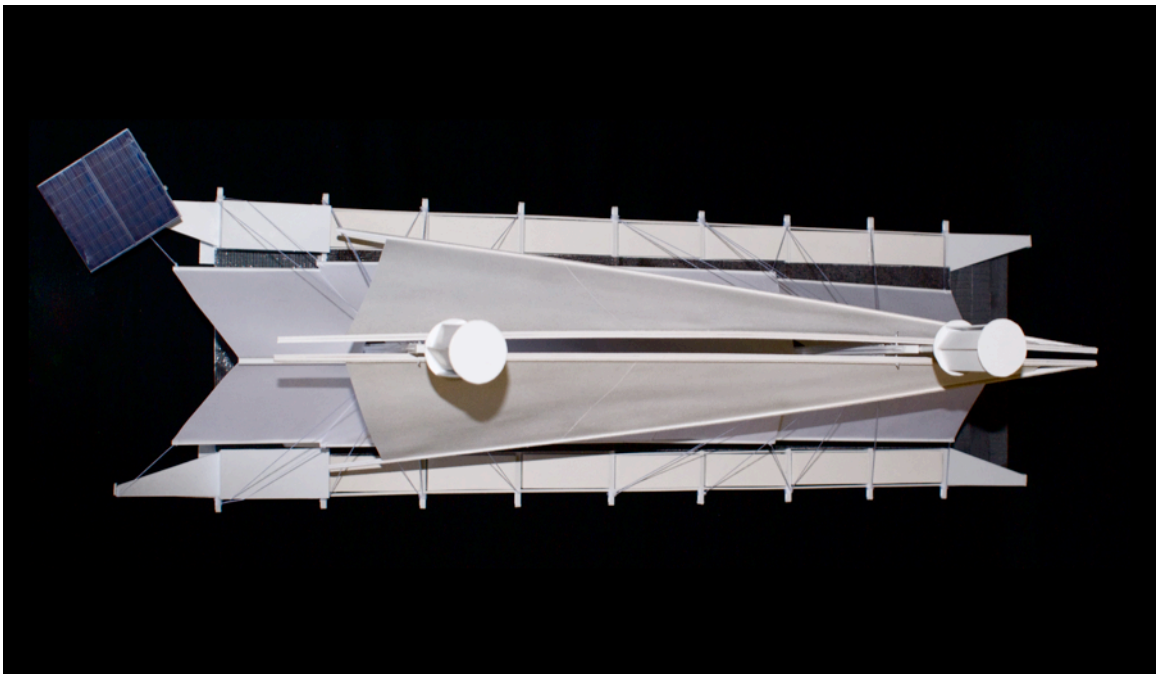
APPENDIX A

MODEL PHOTOGRAPHS

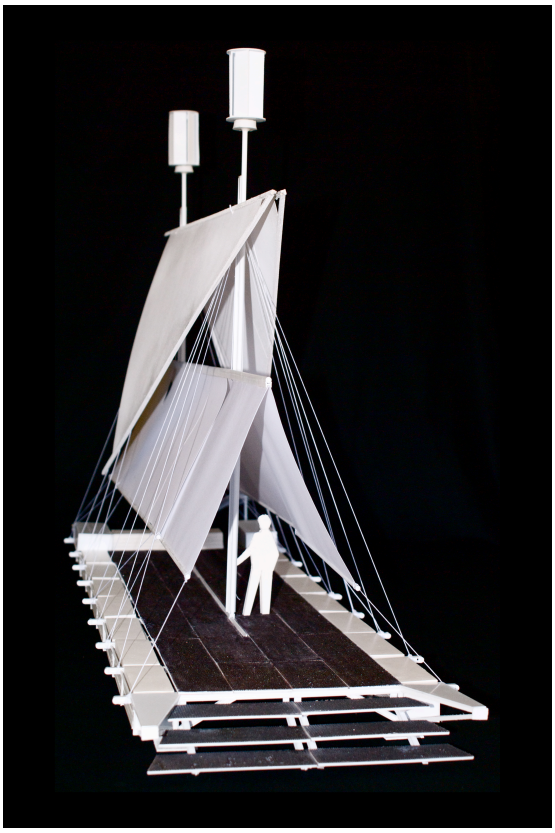
Port Elevation



Roof View

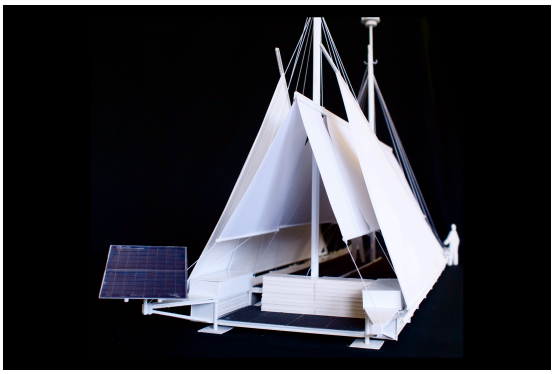


Stern

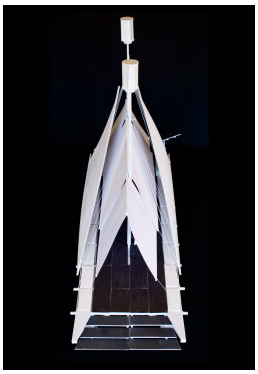


Bow Lighted

Bow with Two Wind Breaks

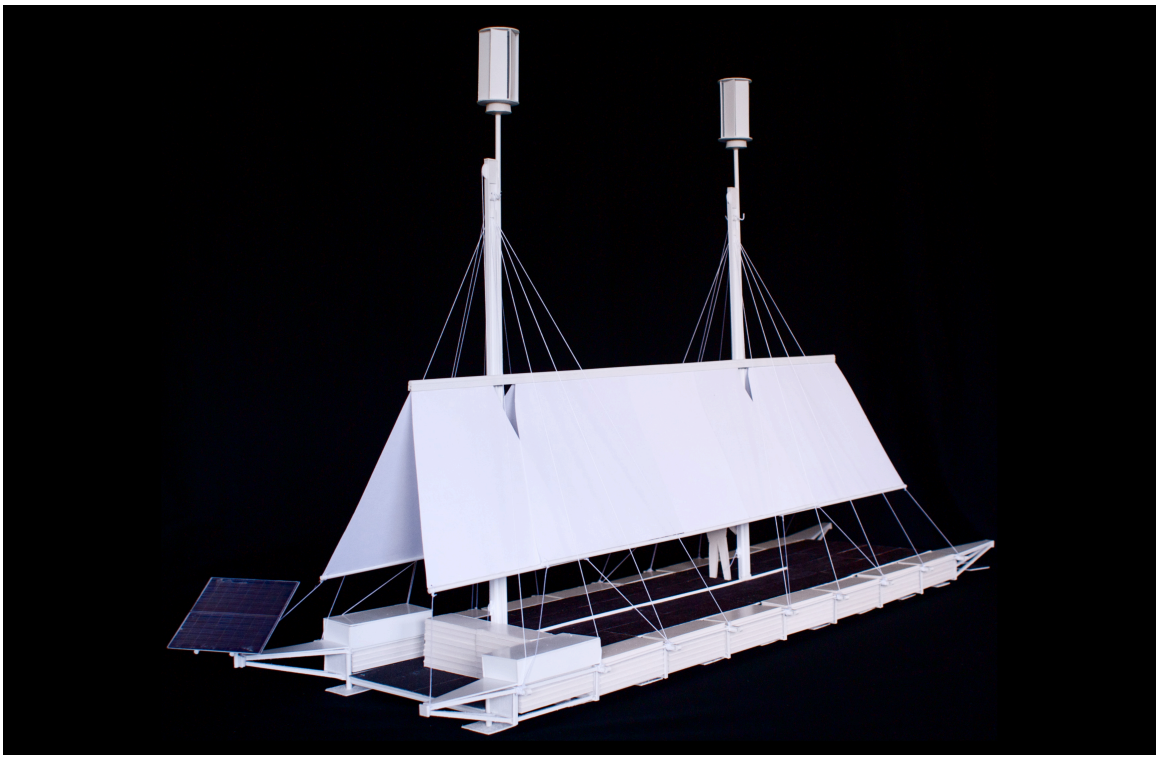


Aerial-1

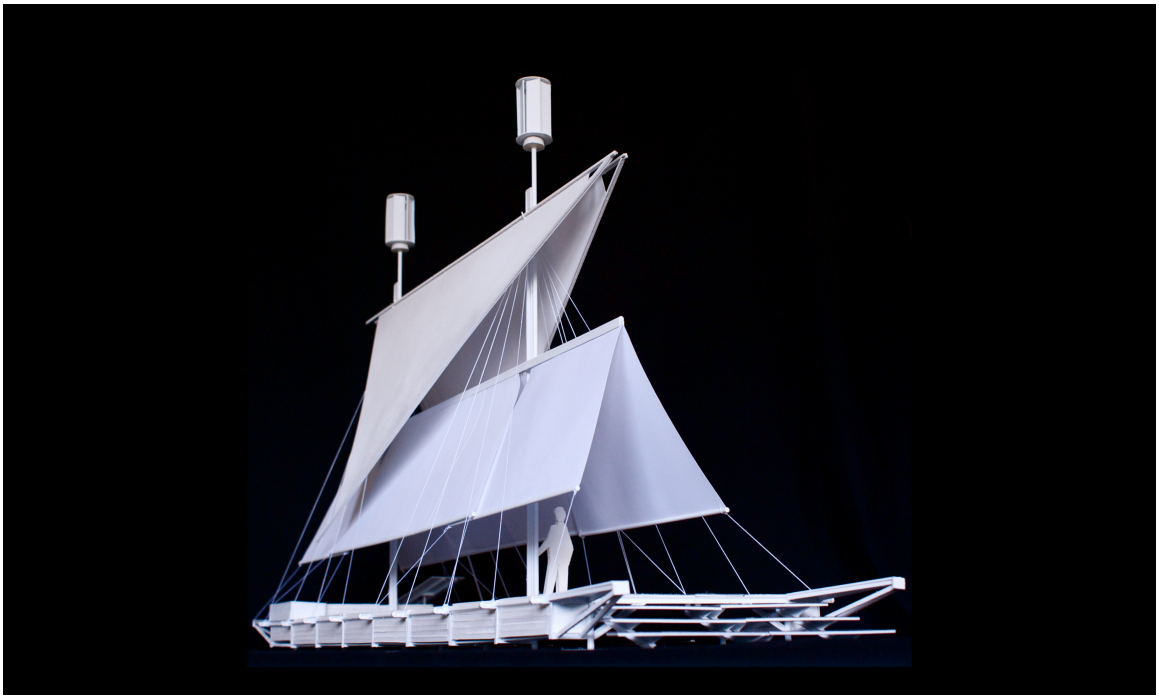


Aerial -2

Moderate Shelter Perspective



Stern Perspective



APPENDIX B

WEIGHT CALCULATIONS

Shipping Weight Estimate

Shipping Weight of CSR-8

Description of Component	Quantity	Unit	lbs./Unit	Extended	Sub-Total
Structural System					
Crossbeam	9		130	1,170	
End Structures	4		27	108	
Stairs	2		40	80	
Deck	648	S.F.	3.58	2,320	
Storage Containers	16		60	960	
Masts (2)	56	Ft.	4.34	243	
Ridge Shelter Spar	42	Ft.	0.82	34	
Powerder Coating	1		20	20	
Stays	480	Ft.	0.20	96	
Turnbuckles	16		1.8	29	
Halyards	1000	Ft.	0.10	100	
Cleats	24		0.40	10	5,170
Electrical System					
Kevin™ LED Deck Light	4		2.5	10	
Sun Dazer Ref/Freezer	2		140	280	
VHF 650 Marine Radio	1		5	5	
SHUflo Water Pump	1		9	9	
Cableing	100	Ft.	0.10	10	314
Power Production					
SeaHawk VAWT	2		139	278	
Tower (2 @ 30 Ft.)	60	Ft.	8	480	
Evergreen Solar ES-A-210	2		42	84	
Sun Tracker	1		30	30	
Controller	1		2	2	
Inverter	1		25	25	
Batteries	4		69	276	
Enclosure	1		45	45	1,220
Service Components					
Sink Module (Empty Water Tank)	1		100	100	
Cooking Module	1		130	130	
Bladder Tank (Empty 10.7'x6'x21")	5		145	725	
Atmospheric Water Generator	1		64	64	1,019
Shelter Enclosures					
Shade Sails	840	S.F.	0.80	672	
Shade Sail Spares	4		22	88	
Moderate Weather Enclosure	1008	S.F.	0.04	40	
Mosquito Net	1056	S.F.	0.03	26	
Full Enclosure	1056	S.F.	0.05	53	880
				Sub-Total	8,602
				10% Contingency	860

Total Shipping Weight of CSR-8 9,462 lbs.

APPENDIX C

ENERGY CALCULATIONS

Energy Calculations **WITHOUT** Atmospheric Water Generator

ALTERNATIVE ENERGY SYSTEM

Direct Current (DC) Power Loads

Description of DC Loads	Volts	Amps	Watts	# of Units	Est. Hours/ Day	Est. Days/ Week	Watt Hours/ Week	% of Power Total
Kevin™ LED Deck Light	12	1.2	14	4	4	4	922	18%
Sun Dazer Ref/Freezer	12	0.51	6	2	24	4	1,175	23%
VHF 650 Marine Radio	12	0.35	4	1	24	4	403	8%
SHUflo Water Pump	12	8.4	101	1	3	4	1,210	24%
						Total Watt Hours / Week	**3,709**	72%

Alternating Current (AC) Power Loads

Description of AC Loads Run by Inverter	Volts	Amps	Watts	# of Units	Est. Hours/ Day	Est. Days/ Week	Watt Hours/ Week	% of Power Total
Outlet for Personal Devices	120	0.42	50	1	1	4	202	4%
Outlet for Power Tools	120	10	1200	1	0.25	4	1,200	23%
~~Atmospheric Water Generator~~	~~115~~	~~15~~	~~450~~	~~0~~	~~24~~	~~7~~	~~0~~	~~0%~~
			Inverter Loss of			*1.15*	30	1%
						Total Watt Hours / Week	**1,432**	28%

Power Totals

System Voltage. Usually 12, 24, or 48 volts.	12 Volts
Total System Watt-Hours per Week (AC+DC)	5,141 Wh / Wk
Total System Watt Hours per Day	1,285 Wh / Day
Average Amp-Hours per Day Required for Operation*	**107 Ah / Day**

Battery Information

Maximum number of continuous cloudy and windless days expected for the area	3 Days
Daily Amp-Hours required for cloudy and windless days with a 50 % reserve after deep discharge of battery storage	643 Ah / Day
Amp-Hours of 6 Volt sealed absorbed glass matt battery	Ah @ 20-200 Hr Rate
Number of specified batteries required *(Rounded up to next whole number)*	**4 Batteries**

NOTES & ASSUMPTIONS

1. Days based on Monday to Thursday volunteer schedule. *4 days used for worst case scenario.
2. 8 cu. ft. Refrigerator uses 12.25 Ah / Day at 80° F.
3. 6 Volt Battery has a dimension of 10.3x7.2x10.9 and weighs 69 lbs.

ALTERNATIVE ENERGY SYSTEM

Wind Turbine Net Power Required to Meet Energy Demands

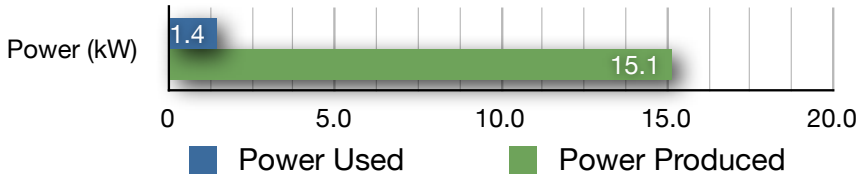
Average Watt-Hours per Day Required for Operation	1,285 Wh / Day
Average Watt-Hours per Day multiplied by 1.12 to compensate for loss from battery charge / discharge	1,440 Wh / Day
Average Operation Hours per Day	24 Wind Hours
Total Turbine Net Power Required	**60 Watts**

Solar Modules Required to Meet Energy Demands

Average Amp-Hours per Day Required for Operation	107 Ah / Day
Average Amp-Hours per Day multiplied by 1.12 to compensate for loss from battery charge / discharge	120 Ah / Day
Average Sun Hours per Day	5 Sun Hours
Total Solar Array Amps Required	24 Amps
Peak Amps of Solar Module Selected	11.2 Amps
Total number of solar modules required *(Rounded up to next whole number)*	**3 Modules**

Energy Sources

Description of Energy Source	Volts	Amps	Watts	# of Units	Est. Hrs/ Day	Amp Hrs/ Day	Watt Hrs/ Day	% of Power Total
PACWIND SeaHawk Vertical Axis Wind Turbine*	12.5	20	250	2	24	960	12,000	79%
Evergreen Solar ES-A-210	18.7	11.2	209	2	5	112	2,094	
Sun Tracker 50% Increase in photovoltaic production							3,142	21%
						Total Amp Hours / Day	1,072	
						Total Watt Hours / Day	**15,142**	



NOTES & ASSUMPTIONS

*Based on 15.9 mph constant yearly wind rate measured near Lua Makika.

Energy Calculations **WITH** Atmospheric Water Generator

ALTERNATIVE ENERGY SYSTEM

Direct Current (DC) Power Loads

Description of DC Loads	Volts	Amps	Watts	# of Units	Est. Hours/ Day	Est. Days/ Week	Watt Hours/ Week	% of Power Total
Kevin™ LED Deck Light	12	1.2	14	4	4	4	922	2%
Sun Dazer Ref/Freezer	12	0.51	6	2	24	4	1,175	3%
VHF 650 Marine Radio	12	0.35	4	1	24	4	403	1%
SHUflo Water Pump	12	8.4	101	1	3	4	1,210	3%
						Total Watt Hours / Week	**3,709**	9%

Alternating Current (AC) Power Loads

Description of AC Loads Run by Inverter	Volts	Amps	Watts	# of Units	Est. Hours/ Day	Est. Days/ Week	Watt Hours/ Week	% of Power Total
Outlet for Personal Devices	120	0.42	50	1	1	4	202	0.48%
Outlet for Power Tools	120	10	1200	1	0.25	4	1,200	3%
Atmospheric Water Generator	115	15	450	1	24	3	32,400	76%
				Inverter Loss of		*1.15*	4,890	12%
						Total Watt Hours / Week	**38,692**	91%

Power Totals

System Voltage. Usually 12, 24, or 48 volts.	12 Volts
Total System Watt-Hours per Week (AC+DC)	42,401 Wh / Wk
Total System Watt Hours per Day	10,600 Wh / Day
Average Amp-Hours per Day Required for Operation*	**883 Ah / Day**

Battery Information

Maximum number of continuous cloudy and windless days expected for the area	3 Days
Daily Amp-Hours required for cloudy and windless days with a 50 % reserve after deep discharge of battery storage	5,300 Ah / Day
Amp-Hours of 6 Volt sealed absorbed glass matt battery	Ah @ 20-200 Hr Rate
Number of specified batteries required *(Rounded up to next whole number)*	**27 Batteries**

NOTES & ASSUMPTIONS

1. Days based on Monday to Thursday volunteer schedule. *4 days used for worst case scenario.
2. 8 cu. ft. Refrigerator uses 12.25 Ah / Day at 80° F.
3. 6 Volt Battery has a dimension of 10.3x7.2x10.9 and weighs 69 lbs.

ALTERNATIVE ENERGY SYSTEM

Wind Turbine Net Power Required to Meet Energy Demands

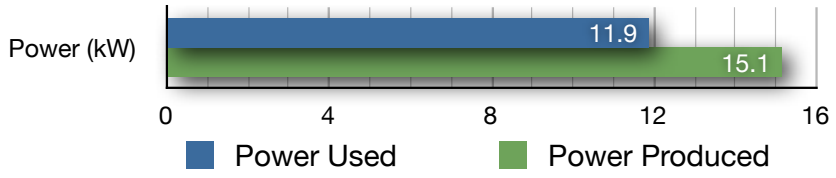
Average Watt-Hours per Day Required for Operation	10,600 Wh / Day
Average Watt-Hours per Day multiplied by 1.12 to compensate for loss from battery charge / discharge	11,872 Wh / Day
Average Operation Hours per Day	24 Wind Hours
Total Turbine Net Power Required	**495 Watts**

Solar Modules Required to Meet Energy Demands

Average Amp-Hours per Day Required for Operation	883 Ah / Day
Average Amp-Hours per Day multiplied by 1.12 to compensate for loss from battery charge / discharge	989 Ah / Day
Average Sun Hours per Day	5 Sun Hours
Total Solar Array Amps Required	198 Amps
Peak Amps of Solar Module Selected	11.2 Amps
Total number of solar modules required *(Rounded up to next whole number)*	**18 Modules**

Energy Sources

Description of Energy Source	Volts	Amps	Watts	# of Units	Est. Hrs/ Day	Amp Hrs/ Day	Watt Hrs/ Day	% of Power Total
PACWIND SeaHawk Vertical Axis Wind Turbine*	12.5	20	250	2	24	960	12,000	79%
Evergreen Solar ES-A-210	18.7	11.2	209	2	5	112	2,094	
Sun Tracker 50% Increase in photovoltaic production							3,142	21%
						Total Amp Hours / Day	1,072	
						Total Watt Hours / Day	**15,142**	



NOTES & ASSUMPTIONS

*Based on 15.9 mph constant yearly wind rate measured near Lua Makika.

APPENDIX D

COST ESTIMATING

Cost Estimate

Material Costs of CSR-8

Description of Materials	Quantity	Unit	$/Unit	Extended	Sub-Total
Structural System					
Crossbeam	8		$1,650	$13,200	
End Structures	4		$200	$800	
Stairs	2		$1,200	$2,400	
Deck	648	S.F.	$10.50	$6,804	
Storage Containers	16		$700	$11,200	
Masts (2)	60	Ft.	$72	$4,320	
Ridge Boom	42	Ft.	$14.70	$617	
Powerder Coating	1		$6,000.00	$6,000	
Stays	480	Ft.	$0.58	$278	
Turnbuckles	16		$30	$480	
Halyards	1000	Ft.	$0.40	$400	
Cleats	24		$8	$192	$46,692
Electrical System					
Kevin™ LED Deck Light	4		$160	$640	
Sun Dazer Ref/Freezer	2		$1,150	$2,300	
VHF 650 Marine Radio	1		$200	$200	
SHUflo Water Pump	1		$98	$98	
Cableing	100	Ft.	$1.50	$150	$3,388
Power Production					
SeaHawk VAWT	2		$4,500	$9,000	
Tower	2		$800	$1,600	
Evergreen Solar ES-A-210	2		$1,407	$2,814	
Sun Tracker	1		$1,000	$1,000	
Controller	1		$500	$500	
Inverter	1		$650	$650	
Batteries	4		$300	$1,200	
Enclosure	1		$500	$500	$17,264
Service Components					
Sink Module	1		$1,000	$1,000	
Cooking Module	1		$1,000	$1,000	
Bladder Tank	1		$600	$600	
Atmospheric Water Generator	1		$2,500	$2,500	$5,100
Shelter Enclosures					
Shade Sails	840	S.F.	$1.90	$1,596	
Shade Sail Spares	4		$10	$40	
Moderate Weather Enclosure	1008	S.F.	$2.60	$2,621	
Mosquito Net	1056	S.F.	$1.50	$1,584	
Full Enclosure	1056	S.F.	$2.80	$2,957	$8,798
				Sub-Total	$81,241
				10% Contingency	$8,124

Total Costs

Best Materials & Maximum Production Capability	**$89,366**
Reduced Production Capability	**$70,000**
Lower Quality Materials & Reduced Production Capability	**$50,000**

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