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Biophilic Design at Pomona College: An Analysis of the New Sontag and Pomona Residence Halls

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BIOPHILIC DESIGN AT POMONA COLLEGE

AN ANALYSIS OF THE NEW SONTAG AND
POMONA RESIDENCE HALLS

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In partial fulfillment of a Bachelor of Arts degree in
Environmental Analysis

Pomona College, Fall 2011
Claremont, CA

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INTRODUCTION

For the past eighteen years, the U.S. Green Building Council (USGBC) has established itself as the most prominent name in the green building industry. With the introduction of its LEED-NC (Leadership in Energy and Environmental Design for New Construction and Major Renovations) rating system in 2000, the USGBC almost single handedly kick-started economic demand for sustainable buildings. Thus far, the USGBC has approached green building by focusing on low-environmental impact design – a design strategy based on minimizing negative environmental impacts. By focusing LEED-NC in this way, the USGBC has achieved considerable good and has increased dramatically in size within an extraordinarily short period of time.¹ Furthermore, because of the USGBC’s efforts, LEED-NC has become the standard by which the majority of new building projects are measured.

While many champion LEED-NC, certain architects and academics believe “a low-environmental impact design approach by itself cannot achieve sustainable development over the long-term.”² Among those who question LEED-NC’s approach is Stephen Kellert, Professor of Social Ecology and Senior Research Scholar at Yale University School of Forestry and Environmental Studies. A detailed examination of the LEED-NC standards demonstrates the validity of Kellert and others’ criticism. The standards stem from the conservationist movement, the evolution and standardization of building technology, and the main tenets of environmental economics. Consequently, LEED-NC functions primarily as “a design-based brand of ratings intended to create a

¹ Kellert, Stephen. *Beyond LEED: From Low-environmental Impact to Restorative Environmental Design*. (2010). p. 1

² *Ibid*, 2

market shift toward sustainability”³ by increasing the amount of low-environmental impact design within the building sector. The language used within LEED-NC demonstrates this fact, as LEED-NC revolves almost solely around how to “prevent”, “reduce”, and “minimize” the negative effects of new construction projects on the natural environment.⁴

Although LEED-NC’s conservationist efforts are admirable, they have not thus far created strong enough incentives for architects to produce completely sustainable buildings.⁵ I believe this is primarily because the standards say little about using sustainable building to encourage biophilia⁶ or to foster positive interactions between a building’s occupants and the natural environment that surround them. Because it does not include biophilia, the LEED-NC standards continue to praise and thus encourage (even if indirectly) the construction of impersonal, aesthetically Modernistic buildings, which are no longer sustainable to construct due to their heavy reliance on air conditioning.

By supporting the continued construction of these buildings, LEED-NC has helped push the green building industry towards “digital architecture”, which seeks to create sustainable buildings using computer modeling, programming, and synthetic technology. As a result of the growing digital architecture craze, even sustainably designed modern buildings, such as those produced according to the LEED-NC system, tend to isolate occupants from nature and oftentimes fail to successfully communicate

³ Turner, Megan. *Is LEED a True Leader?*. (2010) p. 2

⁴ I will use the term “natural environment” to mean “the organic, non-man-made, flora and fauna found in ecosystems.” It should also be noted that the terms “natural environment”, “natural world”, and “nature” will be used interchangeably with one another.

⁵ I will use the term “completely sustainable buildings” to mean “buildings that produce enough energy and filter enough wastewater to power and clean themselves without the need of outside aid.” In other words, sustainable buildings are net-zero energy and net-zero water users.

⁶ Biophilia: the inherent human need for positive contact with nature.

that the buildings' primary purpose is sustainability. This fact is true on Pomona College's campus; it is exemplified by the LEED Silver certified Richard C. Seaver Biology Building, the LEED Gold certified Lincoln-Edmunds buildings, and the newly constructed LEED Platinum certified Sontag and Pomona Residence Halls.

According to a survey adapted from the Council for the Built Environment's (CBC) Indoor Environmental Quality Survey, over one third of surveyed Pomona students who have lived in the new Sontag and Pomona Residence Halls feel that these new buildings, similar to the LEED-NC buildings that came before them at Pomona College, fail to promote positive occupant-nature interactions and sustainable behavior,⁷ even though the new residence halls received the highest possible LEED-NC rating. Through its use of LEED-NC, Pomona College is unintentionally teaching people to avoid direct experiences with nature within the built environment. This is ill advised given the growing body of research that links human beings' mental, physical, and spiritual health directly to their interactions with the natural environment.

To simply conserve energy and reduce water waste through the use of low-environmental impact design will no longer suffice if green building is to begin changing the way human beings live within the built environment. Both LEED-NC and Pomona College should begin to consider requiring environmental architects to focus more on incorporating environmental aesthetics⁸ and biophilic elements within their design. Furthermore, given the USGBC's historic unwillingness to change the LEED-NC standards, Pomona College needs to consider switching to an alternative set of green

⁷ See Appendix 2 for student survey data

⁸ "Environmental aesthetics" is a term I will use to mean "aesthetics that clearly use organic materials, such as living (or formerly living plant matter) or design elements, such as biomimicry."

building standards, such as the Living Building Challenge,⁹ which incorporate the features described above.

By switching to the Living Building Challenge, Pomona College can ensure that it increases the amount of attention its green buildings place on environmental aesthetics as well as ensure that its green buildings successfully communicate their sustainable features and ideals to occupants and visitors. In addition, by using the Living Building Challenge, Pomona College can begin to push green architects to increase the amount of organic¹⁰ and vernacular¹¹ biophilic elements within their designs and start to create highly energy efficient buildings that also improve occupants' health and connect them more with the place in which they are living.

Through a transition from LEED-NC to the Living Building Challenge, Pomona College can help green building start to shake off the effects of the 19th century conservationist paradigm, which has been encouraged by LEED-NC, and create the foundation for a new and improved sustainable building paradigm in which green buildings are viewed as living habitats for people and as positive, well-integrated elements of the larger natural ecosystems that surround them. If successful, Pomona College's green building standards can also begin to foster creativity and positive interactions between human beings and nature within and around the built environment at Pomona College and around the world.

⁹ The Living Building Challenge is an alternative set of green building standards to LEED-NC and will be discussed more in depth later in this thesis.

¹⁰ "Organic biophilic elements" are defined as shapes and forms in the built environment that directly, indirectly, or symbolically reflect the inherent human affinity for nature.

¹¹ "Vernacular biophilic elements" are defined as buildings and landscapes that connect to the culture and ecology of a locality or geographic area.

The aim of this thesis is to place the LEED-NC version 2.2 standards into historical context and to provide a literary criticism of these standards that supports the critique outlined above. This work will also be a case study of the new LEED Platinum certified Sontag and Pomona Residence Halls. It will discuss the aesthetics and energy efficiency of these buildings by examining them through the use of an architectural and energy efficiency analysis. Using this gathered information, along with data from a Pomona College student survey, research from green psychology, and information on the Living Building Challenge, this work will attempt to recommend ways in which Pomona College can alter these new residence halls to become more biophilic and more energy efficient as well as better approach its future green building projects.

CH. 1 – THE LIMITS OF LEED-NC’S CONSERVATIONIST LANGUAGE

LEED-NC Version 2.2 is a set of standards created by the USBGC in 2005 and revised in 2009 designed to judge how sustainable a building is. The standards use a system wherein points are credited to buildings that follow certain sustainable guidelines within their designs and construction. Possible points are organized within the following categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation and Design Process. Each category has multiple subcategories, each of which contains sustainable credits. These sustainable credits are intended to address the reduction of pollution, wildlife disruption, and water and energy use associated with creating sustainable buildings.

While each credit’s intention is clearly designed to increase a given building

project's energy efficiency, the wording used to convey these intentions focuses almost exclusively on *minimizing* the negative effects of the built environment on the natural environment.¹² For example, the intent of LEED-NC's first Sustainability Credit, "Site Selection," is to "avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site."¹³ This initial credit's message bears a strong resemblance to one of the most famous definitions of conservation put forward by Gifford Pinchot, the first Chief of the United States Forest Service. Pinchot defined conservation as "the foresighted utilization, preservation, and/or renewal of forests, waters, lands, and minerals, for the greatest good of the greatest number for the longest time."¹⁴ The similarities between Pinchot's definition of conservation and the intent of LEED-NC's first sustainability credit exemplify LEED-NC's conservationist stance towards green building.

While touting conservation is not a negative act, conservation is effectively the only message that LEED-NC puts forward, as the standards almost completely ignore the possibility for buildings to encourage positive interactions between human beings and the natural environment. This is evidenced by LEED-NC's first Sustainable Sites Prerequisite, entitled "Construction Activity Pollution Prevention Required." This prerequisite is intended to "reduce pollution from construction activities by controlling

¹² It should be noted that although LEED-NC has recently been revised into a new version (3), the critiques presented in this thesis regarding LEED-NC version 2.2 are equally applicable to this new version, as the LEED-NC standards have not been dramatically altered.

¹³ United States Green Building Council. *LEED Green Building Rating System For New Construction & Major Renovations (LEED-NC) Version 2.2*. Washington, DC: U.S. Green Building Council, 2005, p. 9

¹⁴ University of Wisconsin Stevens Point, <http://www.uwsp.edu/forestry/Pages/default.aspx>

soil erosion, waterway sedimentation and airborne dust generation.”¹⁵ To fulfill this prerequisite requirement, LEED-NC requires buildings’ construction plans to: 1) “prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse,” 2) “prevent sedimentation of storm sewer or receiving streams,” and 3) “prevent polluting the air with dust and particulate matter.”¹⁶ LEED-NC’s recommended strategy for achieving this goal is to “select a suitable building location and design the building with the minimal footprint to minimize site disruption of...environmentally sensitive areas.”¹⁷ The language used to describe the intent, requirements, and recommended strategies for achieving this initial site prerequisite are clearly conservationist in tone, as is evidenced by the verbs used: “reduce,” “prevent,” “minimize,” and “protecting.”

Variations of these verbs appear a combined ninety-one times within the LEED-NC standards. “Reduce” and its variations appear fifty-three times while variations of “minimize,” “prevent,” and “protecting” occur twenty-one times, seven times, and ten times respectively. It should also be noted that variations of “avoid” occur seven times within the standards. The extensive use of these verbs further demonstrates LEED-NC’s conservation-oriented, low-environmental impact focus.

Along with LEED-NC’s heavy use of conservationist language, a large portion of LEED-NC’s required prerequisites places a strong emphasis on buildings’ energy efficiency performance. Specifically, the Energy and Atmosphere (EA) Prerequisite 1: “Fundamental Commissioning of the Building Energy Systems Required,” requires “that

¹ United States Green Building Council. *LEED Green Building Rating System For New Construction & Major Renovations (LEED-NC) Version 2.2*. Washington, DC: U.S. Green Building Council, 2005, p. 8

¹⁶ *Ibid*, 8

¹⁷ *Ibid*, 9

[a] building’s energy related systems are installed, calibrated and perform according to the owner’s project requirements, basis of design, and construction documents.”¹⁸

Meanwhile, EA Prerequisite 2: “Minimum Energy Performance Required,” establishes that the building-to-be must achieve a “minimum level of energy efficiency”¹⁹ according to either ASHRAE²⁰ 90.1-2004 or the local energy code, depending on which is more stringent. Finally, EA Prerequisite 3: “Fundamental Refrigerant Management Required,” is designed to “reduce ozone depletion”²¹ by requiring “zero use of CFC-based refrigerants in new base building HVAC&R systems.”²² These prerequisite requirements, of which there are only seven within the entirety of the LEED-NC standards, demonstrate how “the LEED-NC scoring system is weighted heavily toward energy conservation”²³ over all else. Because of this weighting, the standards say little about using green buildings to promote other ways of interacting with the natural environment, such as restoring or redeveloping land and water areas.

This striking lack of messages regarding the potential for green buildings and occupants to interact with the natural environment in a positive way is clear when examining the LEED-NC standards. The encouragement of positive nature-occupant interaction can be seen only once. “Sustainable Site Credit 5.1: Site Development: Protect or Restore Habitat” is designed to “conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.”²⁴ However, to fulfill this credit, LEED-NC gives designers the option of either “restor[ing] or protect[ing] a minimum of

¹⁸ *Ibid*, 29

¹⁹ *Ibid*, 31

²⁰ ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers’

²¹ United States Green Building Council. *LEED-Version 2.2.*, p. 32

²² *Ibid*, 32

²³ Wargo, John. *LEED Building Standards Fail to Protect Human Health*. Yale 360. (Aug. 2010)

²⁴ United States Green Building Council. *LEED-Version 2.2.*, p. 16

50% of the site area”²⁵ or “limit[ing] all site disturbance to 40 feet beyond the building perimeter.”²⁶ As is evidenced by the multiple options presented to fulfill Sustainable Site Credit 5.1, even restoration can be substituted by conservation within the LEED-NC system.

Why do the LEED-NC standards focus on energy efficiency and conservation so strongly while avoiding building policies that restore and regenerate nature? The answer is threefold. The standards are shaped by the history of the U.S. conservation movement, the evolution and standardization of building technology, and the economics of energy efficiency.

Historical Conservationism

LEED-NC’s focus on conservation is partially a reflection of the historical patterns within American environmentalism, specifically the conservation movement. Beginning in the late 19th century, under the influence of earlier thinkers like Henry David Thoreau, conservation became the U.S. environmental movement’s main focus. Important political figures, such as President Theodore Roosevelt and Gifford Pinchot, along with influential writers, such as George Perkins Marsh, John Muir,²⁷ brought the issue of conserving the natural world and its resources to the forefront of the American consciousness. They institutionalized conservation through the creation of natural-resource protection policies, such as the Forest Reserve Act of 1891 and the Reclamation

²⁵ *Ibid*, 16

²⁶ *Ibid*, 16

²⁷ Hillstrom, Kevin. *U.S. Environmental Policy and Politics: A Documentary History*. CQ Press. (2010). p. 91

Act of 1902.²⁸ They also popularized conservation through the establishment of the world's first-ever national park system in 1916. These conservationists and the ethos they advocated championed the need for conserving resources and preserving "wilderness," a term used to describe nature untouched by human beings.

Early conservationists' focus on wilderness soon became an essential part of American culture. In the late 1920's, George Bird Grinnell and the Boone and Crockett Club adopted conservationist attitudes "after reexamining their relationship with the quickly diminishing wild."²⁹ Later in the 1930's, the dust bowl crisis in the south-central United States reaffirmed the need for conservation, as it "awakened America to the wastefulness of farming practices that resulted in devastating soil erosion."³⁰ This period of U.S. environmentalism instilled in many Americans the idea that human beings needed to minimize their impact on the natural world by acting as environmental stewards so as to avoid depleting their natural resources.

The roots of conservationism deepened during the 1960's and 1970's, as a combination of the growth of America's cities and large-scale energy crises forced revisions of earlier conservation ideas and policies to better deal with pollution reduction and energy conservation within urban areas. During this time, "the federal government committed itself to environmental action,"³¹ as it passed the Wilderness Act of 1964, the National Environmental Policy Act (NEPA), and created Earth Day. Meanwhile, the Natural Resources Defense Council and the Environmental Defense Fund took shape to

²⁸ Dinunzio, Mario R., *Theodore Roosevelt*, American Presents Reference Series, CQ Press. (2003). p. 117

²⁹ Neimark, Peninah & Mott, Peter Rhoades, eds., *The Environmental Debate: A Documentary History*. Westport: Greenwood Press. (1999), p. 144

³⁰ *Ibid*, 144

³¹ *Ibid*, 181

support the causes of environmentalists in the courts.³² By 1970, California had even passed a law “requiring environmental impact statements as part of the approval process for new land development projects.”³³

Because of these initiatives, many academics, such as Bill Cronon, believe that land conservation has become an expression of American patriotism and U.S. citizens’ love of country.³⁴ While such associations may seem positive, this belief has effectively separated human beings from the natural world within many people’s minds, as well as relegated humankind to act the role of environmental steward in perpetuity. Consequently, much of the environmental movement approaches sustainability from a conservationist stance. Such thinking is exemplified best within modern green-building practices, such as those touted by LEED-NC, where resource conservation is of utmost importance.

According to LEED-NC’s standards, human beings are not considered as high a priority as natural resource protection. This is evidenced by LEED-NC’s heavy weighting of energy conservation (50 available credits) over human health and safety (16 available credits). Some would argue this imbalance is due to the fact that there are more environmental resources to conserve than there are human needs to fulfill within built structures. However, an examination of the evolution and standardization of building technology and design casts a different light on LEED-NC’s credit weighting decision.

³² *Ibid*, 182

³³ *Ibid*, 182

³⁴ Cronon, William. “*Saving the Land We Love: Land Conservation and American Values*,” Keynote Address for the Land Trust Alliance Rally. Madison, Wisconsin. (October 17, 2005)

The Evolution of Building Technology and the Rise of Modernism

Many of the current LEED-NC standards revolve around the invention of new building technologies. These technologies, many of which were invented during the last century, have greatly affected the way buildings are now constructed. The invention of electric air conditioning marked a huge turning point in the history of building, as it “rendered obsolete all precepts for climatic compensation through structure and form.”³⁵ In other words, architects were able to focus solely on a structure’s aesthetics without concern for the building’s indoor environment or the surrounding natural environment.

Although this gave architects “infinite choices”³⁶ with regards to building form, as so often happens when faced with a great deal of choices, “architects opted for almost perfect homogenization.”³⁷ European and American architects were swept up by the early 20th century’s Futurist inspired belief in a better environment through the exploitation of machine technology.³⁸ In the later thirties, the tone of discussion became moralizing and deterministically Functionalist, as “architects maintained that the public had to accept modern architecture because it was necessary in a technological culture.”³⁹ Consequently, architects adopted the Machine aesthetic, which focused on using modern materials and design ideas in an eclectic fashion to acknowledge the growing importance of industrialization, mass-production, and engineering in the everyday world.

With the Machine aesthetic in mind, many architects began constructing rectilinear buildings that were focused on functionality and extreme simplicity in what

³⁵ Banham, Reyner. *The Architecture of the Well-Tempered Environment*. Chicago Press. (1984). p.187

³⁶ *Ibid*, 190

³⁷ *Ibid*, 190

³⁸ *Ibid*, 124

³⁹ *Ibid*, 124

would come to be known as the International Style, or Modernism. For example, Charles-Édouard Jeanneret, a Modernist French architect (better known as Le Corbusier) and one of the strongest proponents of the Machine aesthetic, proposed that only one type of building should be built for all nations and climates.⁴⁰ Le Corbusier's idealistic building was hermetically sealed and heated (or cooled depending on its location) through the use of air conditioning "to a constant temperature of 18°C."⁴¹ The use of air conditioning was essential to Le Corbusier's design style as it enabled him, along with other Modern architects, "to make Modern buildings habitable by civilized human beings."⁴²

In addition to allowing greater freedom of design, the use of air conditioning also allowed Modern architects to eliminate many of the negative issues within the built environment that were associated with nature, such as extreme temperature changes, allergies, and bothersome insects. Meanwhile, controlling and treating incoming and outgoing air "made millions of hospital patients more comfortable, reduced fetal and infant mortality, and prolonged the lives of thousands of patients suffering from heart disease and respiratory disorders."⁴³ Increased climate control also brought "improved working conditions, greater efficiency, and increased productivity"⁴⁴ to the workplace. Because of these health benefits and the low cost of air conditioning, Modernism's orthogonal, box-type building design "came to dominate the architectural landscape"⁴⁵ as the 20th century progressed. Across the world, many architects began to design glazed,

⁴⁰ *Ibid*, 159

⁴¹ *Ibid*, 159

⁴² *Ibid*, 162

⁴³ Arsenault, Raymond. *The End of the Long Hot Summer: The Air Conditioner and Southern Culture*. *The Journal of Southern History*, Vol. 50, No. 4. p. 617

⁴⁴ *Ibid*, 620

⁴⁵ Pearson, David. *New Organic Architecture: The Breaking Wave*. Gaia Books Limited. (2001). p. 8

rectangular-slab-block buildings that were similar in terms of their aesthetics and their obligatory use of air conditioning.⁴⁶

Because of its energy intensive design, many have critiqued Modernism and its use of air conditioning over the years. Among these is historian Raymond Arsenault, who argues that “air conditioning changed the goal of buildings, as it ushered in the age of mass-produced, homogeneous architecture.”⁴⁷ Arsenault, whose opinions are shared by others like scientist Stan Cox⁴⁸ and author Reyner Banham,⁴⁹ also believes that “because of air conditioning, a rich tradition of vernacular architecture,”⁵⁰ made up of a catalogue of structural techniques developed to tame every type of climate, “has been forgotten for the most part.”⁵¹ This is evidenced by the fact that the science of passive cooling, which was refined over several centuries, “was rendered obsolete in less than a decade”⁵² after the introduction of air conditioning in 1902.

Meanwhile other common critiques of Modernism identify Modern buildings with descriptions such as “cold, hard, empty looking, ultra logical, unimaginative and mechanistic in every detail.”⁵³ This sentiment is echoed by contemporary thinkers, such as Dr. George Ulrich, who feels that the Modern style’s “emphasis on functionality and

⁴⁶ Banham, Reyner. *The Architecture of the Well-Tempered Environment*. p. 159

⁴⁷ Arsenault, Raymond. *The End of the Long Hot Summer: The Air Conditioner and Southern Culture*. p. 624

⁴⁸ Stan Cox is senior scientist at a nonprofit agricultural research institute in Salina, Kansas.

⁴⁹ Reyner Banham was a prolific architectural critic and writer best known for his theoretical treatise *Theory and Design in the First Machine Age* (1960) and for his 1971 book *Los Angeles: The Architecture of Four Ecologies*.

⁵⁰ Vernacular architecture: a term used to describe methods of construction that create connections between a building project and its location. Vernacular architecture is achieved through the use of locally available resources and traditions, which serve to address local needs and circumstances.

⁵¹ Arsenault, Raymond. *The End of the Long Hot Summer: The Air Conditioner and Southern Culture*. p. 623

⁵² *Ibid*, 624

⁵³ Banham, Reyner. *The Architecture of the Well-Tempered Environment*. p. 124

efficiency oftentimes produces sterile and starkly institutional indoor environments, which are stressful and otherwise unsuited to the emotional or physiological needs of occupants and visitors.”⁵⁴ Even Frank Lloyd Wright, one of the greatest American architects of the 20th century, believed that “human interaction with the natural environment had decreased significantly since the advent of air conditioning”⁵⁵ and Modernistic design. In other words, modern building technology and construction methods have tended to “increase people’s separation, isolation, and alienation from beneficial contact with nature.”⁵⁶

The green building movement has attempted to rectify Modernism’s energy-intensive, one-size-fits-all construction style by refocusing the goals of the building sector around the effect of structures-to-be on their surrounding natural environment. Site footprint, light pollution, as well as water and energy conservation have all become central concerns for those in the green building industry, such as the USGBC. However, while attempting to reconnect buildings with nature, green designers have continued to use contemporary building technology and elements of the Machine aesthetic. This has caused the continued creation of boxy, impersonal buildings that overly insulate human beings from the natural environment.

Contemporary green building has also fanned the flame of the “digital architecture” age in which the use of technology has become all-important. Consequently, not only do many of today’s green buildings pride themselves on using the

⁵⁴ Marcus, Clare Cooper & Barnes, Marni. *Healing Gardens: Therapeutic Benefits and Design Recommendations*. p. 27

⁵⁵ Arsenault, Raymond. *The End of the Long Hot Summer: The Air Conditioner and Southern Culture*. p. 623

⁵⁶ Kellert, Stephen. *Beyond LEED: From Low-environmental Impact to Restorative Environmental Design*. p. 1

newest, most efficient types of air conditioning systems money can buy, they also rarely utilize elements from the natural environment, be it living organisms, organic materials, or organic shapes.⁵⁷ In other words, few modern green buildings incorporate any biophilic or organic design elements, which as architect David Pearson argues, “work with nature and allow optimum shapes and forms to be developed that are more efficient, economic, and appropriate to local climate and environmental conditions.”⁵⁸

Overall, few green buildings have made real changes to the modern building style; they have only improved it and lessened its negative environmental impacts. Even the highest quality green buildings constructed today, such as those produced according to the LEED-NC standards, do not reflect a true reintegration of buildings, people, and the nature that surrounds them. Because of this, there is “a danger that instead of being the vanguard of a new holistic architecture, sustainable architecture will become engrossed in high-tech and energy-saving issues.”⁵⁹ The primary reason for green building’s nearly single-minded focus on energy efficiency is the current driving force behind all energy-efficiency policies, environmental economics.

The Economics of Conservation and Energy Efficiency⁶⁰

For the most part, environmental economics policies use incentive-based regulations to set emission targets, leaving it up to industry to figure out the best way to

⁵⁷ “Organic shapes” refer to shapes found in nature, many of which are curved.

⁵⁸ Pearson, David. *New Organic Architecture: The Breaking Wave*. p. 8

⁵⁹ *Ibid*, 8

⁶⁰ Calculating environmental externalities, such as positive benefits to human physical and mental health, is a difficult and imprecise process. In comparison, calculating pollution reduction and increased energy efficiency based on the installation of new technologies is quite easy and precise. Currently, environmental economists attempt to reduce pollution and increase energy efficiency through three main policies: incentive-based regulations, command-and-control regulations, and the development and diffusion of new green technologies.

comply.⁶¹ Consequently, a variety of different, sometimes untested, strategies are utilized, making the achievement of predicted pollution and energy use reduction goals somewhat uncertain. Meanwhile, command-and-control solutions typically involve the government-mandated adoption of particular types of CO₂⁶² abatement technology.⁶³ The use of command-and-control technologies almost always ensures the attainment of a predicted goal regarding pollution reduction and increased energy efficiency. This is because these policies require companies to install technologies that only produce a certain amount of pollution, which is calculated by the government. As a result, while incentive-based regulations are being implemented more and more, command-and-control regulation is the current, dominant approach to environmental protection.⁶⁴

Just as with every other sector within the economy, the green building industry has been heavily influenced by command-and-control mandated technological upgrades. Building codes are routinely updated and refined to include more stringent technological and environmental requirements for new structures' design and construction. Be it new standards regarding HVAC systems, more energy efficient lighting, denser insulation, or more efficient water-saving measures, the technology and design of green buildings is continuously evolving due to the efforts of organizations such as the International Code Council.⁶⁵ The frequent use of command-and-control solutions has made the concept of "sustainable building" revolve almost exclusively around reducing energy use and pollution. According to environmental economics, these reductions are improvements, as

⁶¹ Goodstein, Eban S., Economics and the Environment 5th ed., John Wiley and Sons. (2008). p. 12

⁶² CO₂: carbon dioxide

⁶³ *Ibid*

⁶⁴ *Ibid*

⁶⁵ <http://www.iccsafe.org/ABOUTICC/Pages/default.aspx>

the usually negative act of reduction has become a positive. This idealization of “reduction” has pushed environmentalists and green builders to focus on environmental conservation and preservation to the near exclusion of all other policies.

However, I believe it is important for environmental economists, especially those focused on the green building sector, to consider the effects of green buildings on human beings’ physiological and psychological states. While current environmental economics can measure benefits to human beings in the form of consumer and producer monetary surpluses, these figures often do not reflect the psychological and long-term health benefits many people get from living and working within green building environments. In other words, environmental economics can calculate the cost-savings a company or individual receives from installing energy-saving green building technologies within their structure. However, the in-place environmental economics system has difficulty calculating the increased satisfaction a building’s workers or residents receive from having plant or animal life within their workspace or having the ability to see and hear nearby running water.

Because it is so difficult to calculate consumers’ psychological benefits in terms of monetary values, environmental economics attempts to avoid it for the most part. However, by not considering the added value of these difficult-to-quantify benefits of green building, economists are vastly undervaluing certain elements of green design, like biophilia, that have been proven to have large, positive economic effects due to how they make people feel and function on a daily basis.

Numerous scientific studies have already demonstrated that biophilic elements have real, measurable benefits relative to many human performance metrics such as

productivity, emotional well being, stress reduction, learning, and healing.⁶⁶ Biophilic features have also been shown to foster human beings' appreciation of nature, which oftentimes leads to greater protection of natural areas, eliminating pollution, and maintaining a clean environment.⁶⁷ What follows is a brief history of biophilia and a survey of important scientific studies validating biophilia's effects.

CH. 2 – THE BENEFITS OF BIOPHILIA

History

In 1984, American biologist and naturalist E.O. Wilson wrote *Biophilia: The Human Bond With Other Species* in which he sought to provide some understanding of how the human tendency to relate with life and natural processes might be the expression of a biological need. In other words, Wilson sought to demonstrate that human-nature interactions were integral to the human species' developmental process and essential to human beings' physical and mental growth.⁶⁸

To explain this phenomenon, Wilson put forward a biocultural evolutionary theory entitled the “gene-culture coevolution.”⁶⁹ Within this theory, Wilson argued that due to human beings' constant exposure to nature throughout their evolutionary history, biophilia has been genetically encoded within the human psyche.⁷⁰ In other words, Wilson posited that “human culture was elaborated under the influence of hereditary learning propensities while the genes prescribing those propensities were spread by

⁶⁶ Wilson, Alex. "Biophilia in Practice: Buildings that Connect People with Nature," *Environmental building news (1062-3957)*, 15, 7, p. 1

⁶⁷ *Ibid*, 1

⁶⁸ Wilson, Edward O. & Kellert, Stephen. *The Biophilia Hypothesis*. (1993). Island Press. p. 20

⁶⁹ *Ibid*, 33

⁷⁰ *Ibid*, 33

natural selection.”⁷¹ Wilson believed that the combination of these hereditary learning propensities (i.e. repeated experiences), which were encoded by natural selection, and “the strong tendency of human beings to translate emotional feelings into myriad dreams and narratives created the necessary conditions for the origin of biophilia.”⁷²

Wilson’s gene-culture coevolution theory made up a part of his larger “biophilia hypothesis”, which proclaimed that “human dependence on nature extends far beyond simple issues of material and physical sustenance to encompass the human craving for aesthetic, intellectual, cognitive, and even spiritual meaning.”⁷³ Furthermore, Wilson hypothesized that “when human beings remove themselves from the natural environment, the biophilic learning rules are not replaced by modern versions equally well adapted to artifacts.”⁷⁴ Over time, Wilson’s arguments and theories have been supported by multiple scientific studies, such as those conducted by Dr. George Ulrich, Dr. Gregory Diette, and Drs. DeSchraver and Riddick.

Scientific Evidence for Biophilia

In 1984, Dr. George Ulrich, a research scientist at Texas A&M University, tested Wilson’s biocultural theory of biophilia. Specifically, Dr. Ulrich examined the effect of viewing nature on hospital patients recovering from surgery. According to Dr. Ulrich, “if [patient’s] windows overlooked trees rather than a brick building wall”⁷⁵ they had more “favorable recovery courses, including shorter hospital stays and lower intake of potent

⁷¹ *Ibid*, 32

⁷² *Ibid*, 33

⁷³ *Ibid*, 33

⁷⁴ *Ibid*, 32

⁷⁵ Ulrich et al. (1984). View Through a Window May Influence Recovery From Surgery. *Science* 27, 224, pp. 420-421

narcotic pain drugs.”⁷⁶ In addition, “patients with views of nature received more favorable evaluations by nurses.”⁷⁷

In 1991, Dr. Ulrich conducted another study in which he examined whether nature has restorative influences on the emotional, attentional and physiological aspects of human beings’ stress. To investigate this issue, Dr. Ulrich “exposed 120 subjects to a stressful movie and then to a color-and-sound videotape displaying one of six different natural and urban settings.”⁷⁸ During the environmental presentations, “data concerning stress recovery was obtained in the form of self-ratings, heart period, muscle tension, skin conductance and pulse transmit time”⁷⁹ (i.e. blood pressure). Findings from the physiological and verbal measures “converged to indicate that recovery was faster and more complete when subjects were exposed to natural rather than urban environments.”⁸⁰ In other words, findings were consistent with the predictions of Wilson’s theory of biophilia;⁸¹ the results showed that “human interaction with nature oftentimes involves a shift towards a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention.”⁸²

Dr. Ulrich’s studies are supported by data from a similar study⁸³ conducted in - 2003 by Dr. Gregory B. Diette at Johns Hopkins’ Bloomberg School of Public Health. During this study, researchers attempted to determine whether distraction therapy with

⁷⁶ *Ibid*

⁷⁷ *Ibid*

⁷⁸ Ulrich et al. (1991). Stress Recovery During Exposure to Natural and Urban Environments, *Journal of Environmental Psychology*, 11, pp. 201-23

⁷⁹ *Ibid*

⁸⁰ *Ibid*

⁸¹ *Ibid*

⁸² *Ibid*

⁸³ Diette et al (2003). Distraction Therapy With Nature Sights and Sounds Reduces Pain During Flexible Bronchoscopy: A Complementary Approach to Routine Analgesia. *Chest*, 123, 3, pp. 941-948

nature sights and sounds during flexible bronchoscopy⁸⁴ reduces pain and anxiety. To verify this hypothesis, Dr. Diette and his team “placed nature scene murals at patients’ bedsides and provided patients with a tape of nature sounds to listen to before, during, and after they underwent a bronchoscopy procedure.”⁸⁵ Patients assigned to the control group were not offered either the nature scene or the sounds.⁸⁶ Results from this study, which were analyzed using a multivariate ordinal logistic regression (that adjusted for age, gender, race, education, health status, and intake of narcotic medication), showed that “the odds of better pain control were greater in the intervention patients than in the control patients.”⁸⁷ In other words, patients who were assigned to look at a ceiling-mounted nature mural reported less pain than patients assigned to look at a blank ceiling. Similar to Dr. Ulrich’s studies, Dr. Diette et al.’s study demonstrates that nature serves as a positive distraction that reduces stress and diverts patients from focusing on their pain or distress.

In addition to Dr. Ulrich and Dr. Diette et al.’s findings, Dr. Mary M. DeSchrive⁸⁸ and Dr. Carol C. Riddick⁸⁹ have also found proof that further validates Wilson’s biophilia hypothesis. In 1990, Drs. DeSchrive and Riddick examined the measurable (i.e. physiological) relaxation effects for elderly persons viewing fish in an

⁸⁴ Bronchoscopy: a technique of visualizing the inside of the airways for diagnostic and therapeutic purposes wherein an instrument (bronchoscope) is inserted into the lungs through the nose or mouth.

⁸⁵ Diette et al (2003). Distraction Therapy With Nature Sights and Sounds Reduces Pain During Flexible Bronchoscopy: A Complementary Approach to Routine Analgesia. *Chest*, 123, 3, pp. 941-948

⁸⁶ *Ibid*

⁸⁷ *Ibid*

⁸⁸ Dr. Deschrive is Director of the Therapeutic Recreation Department, Presbyterian Home of Greater Washington, D.C.

⁸⁹ Dr. Riddick is Associate Professor in the Department of Physical Education and Recreation at Gallaudet University

aquarium. Their study consisted of “three eight-minute treatment sessions held one week apart, wherein one experimental group watched a fish aquarium or a videotape of fish swimming, while the control group viewed a placebo videotape.”⁹⁰ Members of all three groups (who were all 62 years old or above) perceived their treatments as relaxing.⁹¹ However, “aquarium observers tended to experience a decrease in pulse rate and muscle tension, as well as an increase in skin temperature, all of which are beneficial for health in the long run.”⁹² Furthermore, it became apparent to Drs. DeSchraver and Riddick that the live fish acted as a “social lubricant” for the experimental group, who were much more likely to talk to one another than other groups that were tested.⁹³ This study demonstrates the calming effects that animals have on human beings on both a conscious and subconscious level as well as animals’ ability to bring people closer together.

Drs. DeSchraver and Riddick’s findings regarding animals’ beneficial impact on human health are by no means unique. Other reports, such as those produced by Patronek and Glickman (1993)⁹⁴ and Allen et al. (2001),⁹⁵ “link pet ownership to a lowering of high blood pressure and improved survival after heart attacks.”⁹⁶ Meanwhile, Carson and Carson (1977) demonstrated that depressed and asocial patients (such as those with

⁹⁰ DeSchraver, Mary M. & Riddick, Carol Cutler. (1990). Effects of Watching Aquariums on Elders' Stress. *Anthrozoos*, 4, 1, pp. 44-48

⁹¹ *Ibid*

⁹² *Ibid*

⁹³ *Ibid*

⁹⁴ Patronek, G.J. & Glickman, L.T. (1993). Pet Ownership Protects Against the Risks and Consequences of Coronary Heart Disease. *Medical Hypothesis*, 40, 4, pp. 245-249

⁹⁵ Allen, Karen; Shykoff, Barbara E. & Izzo Jr., Joseph L. (2001). Pet Ownership, but Not ACE Inhibitor Therapy, Blunts Home Blood Pressure Responses to Mental Stress. *Department of Medicine, State University of New York at Buffalo*.

⁹⁶ Louv, Richard. *Last Child in the Woods: Saving our Children from Nature-Deficit Disorder*. Algonquin Books of Chapel Hill. (2005). p. 45

autism and Alzheimer's) experience positive social responses to interacting with animals.⁹⁷

Because of the plethora of scientific studies demonstrating the positive effects of human beings' interaction with living organisms and nature, certain scholars, such as Stephen Kellert, have attempted to come up with general ways in which to integrate natural elements within the built environment. In 2005, Kellert created six basic biophilic design elements that satisfy what he believes are biophilic design's two main dimensions.

Biophilic Design Basics

According to Kellert,⁹⁸ one of the leading scholars on biophilia, there are two basic dimensions of biophilic design: an organic or naturalistic dimension and a place-based or vernacular dimension.⁹⁹ Kellert defines the organic dimension of biophilic design as "shapes and forms in the built environment that directly, indirectly, or symbolically reflect the inherent human affinity for nature."¹⁰⁰ Meanwhile, Kellert defines the vernacular dimension of biophilia as "buildings and landscapes that connect to the culture and ecology of a locality or geographic area."¹⁰¹

Kellert is quite specific with what he means by the organic dimension of biophilic design, as he cites "daylight, plants, animals, natural habitats, and ecosystems"¹⁰² as examples of direct experiences of organic biophilic design. In addition, Kellert defines

⁹⁷ Wilson, Edward O. & Kellert, Stephen. *The Biophilia Hypothesis*. p. 178

⁹⁸ Stephen Kellert is a Professor of Social Ecology and Senior Research Scholar at the Yale University School of Forestry and Environmental Studies.

⁹⁹ Kellert, Stephen. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*. 2008. John Wiley and Sons Inc.

¹⁰⁰ *Ibid*

¹⁰¹ *Ibid*

¹⁰² *Ibid*

indirect experiences of organic biophilia as “contact with elements of nature that require ongoing human input to survive, such as a potted plant, water fountain, or aquarium.”¹⁰³

Meanwhile, Kellert defines symbolic or vicarious experiences of organic biophilia as “encounters involving no actual contact with real nature, but rather the representation of the natural world through image, picture, video, and metaphor.”¹⁰⁴

Over time, Kellert has also expanded his definition of biophilia’s vernacular dimension to include “buildings and landscapes that foster an attachment to place by connecting culture, history, and ecology within a geographic context.”¹⁰⁵ Kellert believes this vernacular element underscores how “certain meaningful buildings and landscapes become integral to people’s individual and collective identities.”¹⁰⁶ In other words, Kellert believes that people’s emotions toward a place or structure can “metaphorically transform inanimate matter into something that feels lifelike and is often life sustaining.”¹⁰⁷

By using these two dimensions of biophilic design as a framework, Kellert has formulated six, basic biophilic design elements: environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships, and evolved human-nature relationships. Within his book *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*, Kellert provides a table (Figure 1) with examples of each of the six basic biophilic design elements.

¹⁰³ *Ibid*

¹⁰⁴ *Ibid*

¹⁰⁵ *Ibid*

¹⁰⁶ *Ibid*

¹⁰⁷ *Ibid*

Figure 1

TABLE 1-1 Elements and Attributes of Biophilic Design

Environmental features	Natural shapes and forms	Natural patterns and processes
Color Water Air Sunlight Plants Animals Natural materials Views and vistas Façade greening Geology and landscape Habitats and ecosystems Fire	Botanical motifs Tree and columnar supports Animal (mainly vertebrate) motifs Shells and spirals Egg, oval, and tubular forms Arches, vaults, domes Shapes resisting straight lines and right angles Simulation of natural features Biomorphy Geomorphology Biomimicry	Sensory variability Information richness Age, change, and the patina of time Growth and efflorescence Central focal point Patterned wholes Bounded spaces Transitional spaces Linked series and chains Integration of parts to wholes Complementary contrasts Dynamic balance and tension Fractals Hierarchically organized ratios and scales
Light and space	Place-based relationships	Evolved human-nature relationships
Natural light Filtered and diffused light Light and shadow Reflected light Light pools Warm light Light as shape and form Spaciousness Spatial variability Space as shape and form Spatial harmony Inside-outside spaces	Geographic connection to place Historic connection to place Ecological connection to place Cultural connection to place Indigenous materials Landscape orientation Landscape features that define building form Landscape ecology Integration of culture and ecology Spirit of place Avoiding placelessness	Prospect and refuge Order and complexity Curiosity and enticement Change and metamorphosis Security and protection Mastery and control Affection and attachment Attraction and beauty Exploration and discovery Information and cognition Fear and awe Reverence and spirituality

Throughout the past five years, Kellert has expanded on these basic biophilic design elements to create a sustainable building approach that he calls “restorative environmental design.”¹⁰⁸ Restorative environmental design emphasizes two complementary goals: “(1) minimizing, and mitigating the adverse effects of building construction and development on natural systems and human health, and (2) promoting positive interactions between people and nature in the built environment.”¹⁰⁹ As is evident, Kellert’s restorative environmental design seeks to go beyond low-environmental impact design by making it a point to create positive human-nature interactions within human-made structures.

¹⁰⁸ Kellert, Stephen. *Building for Life: Designing and Understanding the Human-Nature Connection*. Island Press. (2005). p. 4

¹⁰⁹ *Ibid*, 123

By using elements of Kellert and Wilson’s work, green building groups, such as the Cascadia Green Building Council, have been able to create new, innovative, and exciting sustainable building design standards, like the Living Building Challenge (LBC), based around restorative environmental design.

CH. 3 - THE LIVING BUILDING CHALLENGE

The Living Building Challenge (LBC) is a “cohesive set of green building standards that pulls together the most progressive thinking from the worlds of architecture, engineering, planning, landscape design, and policy.”¹¹⁰ The idea for a “living building” first emerged in the mid-1990s during the creation of the National Institute of Standards and Technology-funded EpiCenter project.¹¹¹ The goal of the EpiCenter project was to produce the most advanced sustainable design project in the world.¹¹² In 2005, the theoretical idea of a ‘living’ building was turned into a codified standard: the Living Building Challenge version 1.0.

The LBC, which was formally launched in 2006 by the Cascadia Green Building Council and later revised in 2009, has a similar structure to the LEED-NC system. The LBC lays out a set of point-based guidelines designed to help builders construct the “greenest” building projects possible. Specifically, the LBC’s guidelines challenge: 1) “design professionals, contractors and building owners to create the foundation for a

¹¹⁰ Cascadia Green Building Council. *Living Building Challenge version 2.0*. (2009) p. 5

¹¹¹ *Ibid*, 47

¹¹² *Ibid*, 47

sustainable future in the fabric of our communities,”¹¹³ 2) “politicians and government officials to remove barriers to systemic change, and to realign incentives and market signals that truly protect the health, safety and welfare of people and all beings,”¹¹⁴ and 3) “all of humanity to reconcile the built environment with the natural environment, into a civilization that creates greater biodiversity, resilience and opportunities for life with each adaptation and development.”¹¹⁵

The LBC’s point-based guidelines are divided into seven performance areas, or “Petals”: Site, Water, Energy, Health, Materials, Equity and Beauty. Petals are subdivided into a total of twenty “Imperatives”, each of which focuses on a specific environmental concern related to a given Petal’s sphere of influence. The LBC claims that this compilation of Imperatives can be applied to almost every conceivable project type, be it a building, landscape, or community development. Building projects that accumulate enough points are certified as “living buildings” by the LBC.

Although the LBC appears superficially similar to LEED-NC, the two green building standards differ in six important regards: tone of language, stringency of energy efficiency, voluntariness of design guidelines, incorporation of aesthetics, certification process, and approach to sustainable building.

LBC Language

In contrast to LEED-NC’s negatively focused, conservationist language, the language used within the LBC is quite positive, as it is oriented primarily towards the restoration and regeneration of the natural environment. This is evidenced by the way the

¹¹³ *Ibid*, 3

¹¹⁴ *Ibid*, 3

¹¹⁵ *Ibid*, 3

LBC describes the general purpose and intent of each Petal and Imperative within its standard. For example, the LBC’s Site Petal is designed to “restore a healthy coexistence with nature.”¹¹⁶ In addition, the intent of the Site Petal is “to clearly articulate where it is acceptable for people to build, how to protect and restore a place once it has been developed, and to encourage the creation of communities that are once again based on the pedestrian rather than the automobile.”¹¹⁷ The Site Petal demonstrates how the LBC seeks to create a positive relationship between human beings and the natural world, rather than attempting to place the natural environment within a separate sphere from human beings, as LEED-NC does.

The LBC’s efforts at focusing its standards around ensuring that human beings have a role within both the built and the natural environments can also be seen within the LBC’s Health Petal, which seeks “to maximize physical and psychological health and well being.”¹¹⁸ The LBC argues that “most buildings provide substandard conditions for health and productivity”¹¹⁹ and that there is often “a direct correlation between decreased comfort and increased environmental impacts, since solutions in the physical environment to improve well-being are often energy-intensive and wasteful.”¹²⁰ Consequently, the LBC seeks to use its Health Petal to inspire the creation of “nourishing, highly productive and healthful indoor environments.”¹²¹ The LBC promotes the creation of such buildings by setting the intent of the Health Petal as follows: “to focus on the major conditions that must be present to create robust, healthy

¹¹⁶ *Ibid*, 14

¹¹⁷ *Ibid*, 14

¹¹⁸ *Ibid*, 24

¹¹⁹ *Ibid*, 24

¹²⁰ *Ibid*, 24

¹²¹ *Ibid*, 24

spaces, rather than to address all of the potential ways that an interior environment could be compromised.”¹²²

To insure this outcome, the LBC created the Health Petal with three Imperatives, “Civilized Environment”, “Healthy Air”, and “Biophilia.” These imperatives seek to force the incorporation of “operable windows,”¹²³ “good indoor air quality,”¹²⁴ “fresh air and daylight,”¹²⁵ and the inclusion of “elements that nurture the innate human attraction to natural systems and processes”¹²⁶ within all LBC-certified projects. As is evidenced by the Health Petal, the LBC has a generally positive view regarding the ways in which human beings and the natural environment should interact compared to LEED-NC’s resource-focused, conservationism.

Stringent Energy Efficiency Standards

Three out of the LBC’s seven Petals are focused on energy and resource efficiency. One of these is the LBC’s Water Petal, which was created with the intent to “realign how people use water and redefine ‘waste’ in the built environment, so that water is respected as a precious resource.”¹²⁷ Consequently, the Water Petal includes an Imperative entitled, “Net Zero Water”. This Imperative requires that “one hundred percent of occupants’ water use [within living buildings] must come from captured precipitation or closed loop water systems that account for downstream ecosystem

¹²² *Ibid*, 24

¹²³ *Ibid*, 25

¹²⁴ *Ibid*, 26

¹²⁵ *Ibid*, 25

¹²⁶ *Ibid*, 27

¹²⁷ *Ibid*, 19

impacts and that are appropriately purified without the use of chemicals.”¹²⁸ The Water Petal’s high standards demonstrate the seriousness with which the LBC takes water use efficiency, in sharp contrast to LEED-NC, which does not even mention water recycling or purification.

The LBC’s focus on Net Zero resource use can also be seen within the LBC’s Energy Petal. Specifically, the Energy Petal’s Net Zero Energy Imperative requires “one hundred percent of the project’s energy needs to be supplied by on-site renewable energy on a net annual basis.”¹²⁹ Just as with the Water Petal, the LBC seeks to push buildings to a whole new level of resource efficiency (compared to LEED-NC) through its use of the Energy Petal. Because of the LBC’s stringent standards, all LBC certified living buildings are among the most energy efficient buildings in the world.

Voluntary vs. Mandatory Design Guidelines

Unlike LEED-NC’s optional credits approach, all of the LBC’s proposed design guidelines (i.e. Imperatives) are mandatory for designers to fulfill when planning and constructing living buildings. As a result, although it is quite difficult to simultaneously achieve all of the LBC’s requirements, certified living buildings are more holistic in their approach to sustainability than most LEED-NC-certified buildings and are thus less single-minded in their focus on resource conservation. This fact is further exemplified by the LBC’s goal to be “a unified tool for transformative design, allowing [human beings] to envision a future that is Socially Just, Culturally Rich and Ecologically Benign.”¹³⁰

¹²⁸ *Ibid*, 20

¹²⁹ *Ibid*, 23

¹³⁰ *Ibid*, 5

Incorporation of Aesthetics

As part of its effort to ensure holistic sustainable design, the LBC includes a Petal entitled “Beauty.”¹³¹ The first Imperative of this Beauty Petal states that a “project must contain design features intended solely for human delight and the celebration of culture, spirit and place appropriate to its function.”¹³² In other words, all living buildings must attempt to be aesthetically pleasing, well suited to their site, as well as sustainable in terms of resources use. By making designers concentrate strongly on the aesthetics of each building project, the LBC forces them “to recognize the need for beauty as a precursor to caring enough to preserve, conserve, and serve the greater good.”¹³³

To further encourage designers to focus on aesthetics, the LBC also requires “each of the six established Biophilic Design Elements¹³⁴ [to] be represented for every 2,000 m² of [each] project.”¹³⁵ The LBC’s mandatory inclusion of biophilia reinforces the idea that environmentally conscious structures must not only function sustainably within nature, but also attempt to look like part of the natural environment that surrounds them.

Because of the LBC’s focus on aesthetics and biophilia, the living buildings that have been produced thus far are quite remarkable. For example, the LBC-certified Omega

¹³¹ It should be noted that “in this [Beauty] Petal, the Imperatives are based merely on genuine efforts” as the [Cascadia Green Building Council] does not begin to assume [it] can judge beauty and project [its] own aesthetic values on others.” The Cascadia Green Building Council only “wants to understand people’s objectives and know that an effort was made to enrich people’s lives with each square meter of construction on each project” and that “this intentionality must carry forth into a program for educating the public about the environmental qualities of [each] Living Building Challenge project.”

¹³² *Living Building Challenge, version 2.0*, p. 41

¹³³ *Ibid*, 40

¹³⁴ The six established Biophilic Design Elements are: environmental features, natural shapes and forms, natural patterns and processes, light and space, place-based relationships, and evolved human-nature relationships. These biophilic design elements will be discussed in greater detail later in this chapter.

¹³⁵ *Living Building Challenge version 2.0*. p. 27

Center for Sustainable Living is a wastewater filtration facility located in Rhinebeck, New York and is designed to use an Eco Machine greywater recovery system¹³⁶ to treat its wastewater on site and then recycle that water for other uses, such as garden irrigation.¹³⁷ In addition to being a water-waste-processing machine, the Omega Center for Sustainable Living was constructed using primarily organic materials. All of the building's exterior walls are made of minimally treated wood (Figure 2),¹³⁸ a fact that gives the Omega Center's exterior the look of something that could be found in the natural environment. Additionally, the fact that the building is partially surrounded by four man-made wetlands, all of which are filled with tall green reeds (Figure 3), further adds to the building's clear environmental aesthetics.

Figure 2



¹³⁶ The Omega Center's Eco Machine is a seven-step water reclamation system that cleans water by mimicking the processes of the natural world. Specifically, all the water from the Omega Center for Sustainable Living's campus, including water used in toilets, showers, and sinks, flows to the Eco Machine, where it is purified by microscopic algae, fungi, bacteria, plants, and snails, after being separated and equalized in various tanks. The purified water is then returned to the aquifer deep beneath the Omega Center for Sustainable Living before it is used again within the Omega Center's toilets, showers, and sinks.

¹³⁷ <https://ilbi.org/lbc/casestudies/omega/home>

¹³⁸ <http://www.omega.org/omega/about/ocsl/gallery/?image=96&category=finished-building>

Figure 3



The importance of these wetlands to the site is also prominently featured within the interior of the Omega Center for Sustainable Living. Specifically, two aerated lagoons (Figure 4), which serve as part of the Eco Machine mentioned above, are housed within a 4,500 square foot greenhouse that makes up a significant portion of the Omega Center's site footprint. These lagoons, which are covered with large amounts of greenery, increase the amount of biophilia within the Omega Center for Sustainable Living and give occupants and visitors of the Omega Center a strong feeling that the natural and built environments share a mutually beneficial connection to one another.

Figure 4



Certification Process

LEED-NC and the LBC differ significantly in their accreditation policies. While LEED-NC certifies its buildings based solely on predicted energy efficiency (i.e. computer generated models),¹³⁹ the LBC only certifies its buildings based on measured energy efficiency. Specifically, projects certified under the LBC must be operational for at least one year prior to evaluation. This waiting period is designed to ensure living buildings' adequate post-construction performance in terms of energy efficiency and overall sustainability, as the LBC certification validates actual performance, not projected performance.

The success of the LBC's certification approach is evidenced by the Hawaii Preparatory Academy Lab, which uses only 19,090 kWh/yr¹⁴⁰ of electricity, while generating 38,994 kWh/yr.¹⁴¹ The Hawaii Preparatory Academy Lab's energy production, which it achieves through the use of three discrete arrays of photovoltaic panels, is greater than predicted by nearly 1,500 kWh/yr.¹⁴² Because of the sites energy production, the whole structure is net zero in terms of electricity use.

In addition, the Omega Center for Sustainable Living described above, is also extremely energy efficient. Its designers predicted that its annual energy use would be 48,460 kWh/yr.¹⁴³ However, the structures' actual annual energy use only ended up being

¹³⁹ According to Megan Turner, "at the moment post-construction data [for LEED-certified buildings] has no bearing on buildings' certification status, which means that structures using more energy or water than expected still retain the credits they earned during the design and construction phases; thus, a building's LEED rating is based entirely on its compliance to design standards, not its actual performance. (p. 2)

¹⁴⁰ kWh/yr: kilowatt hours per year

¹⁴¹ <https://ilbi.org/lbc/casestudies/HPAenergylab/energy>

¹⁴² *Ibid*

¹⁴³ <https://ilbi.org/lbc/casestudies/omega/energy>

37,190 kWh/yr.¹⁴⁴ The Center's success in exceeding its predicted energy efficiency is the reverse of many LEED-NC certified buildings, such as Pomona College's Lincoln-Edmunds buildings, which often predict much lower energy usage than their actual performance requires.¹⁴⁵

For the past five years, many have demanded that the USGBC institute post-inspection regulations as part of the LEED-NC standards.¹⁴⁶ However, the USGBC has thus far refused to alter LEED-NC to include a post-inspection component because the USGBC claims that "LEED is a design-based brand of ratings intended to create a market shift toward sustainability, and that low prerequisites help encourage more developers to try building green for the first time."¹⁴⁷ I believe the USGBC's unwillingness to include a post-inspection component is unacceptable given LEED-NC's current domination of the green building market. By refusing to create more stringent post construction policies, the USGBC is misleading people into thinking that the current methods of green building promoted by the LEED-NC standards, if applied around the world, will significantly help to mitigate anthropogenic climate change. However, this is simply not the case given LEED-NC-certified buildings consistent underperformance in terms of energy efficiency.¹⁴⁸

¹⁴⁴ *Ibid*

¹⁴⁵ Turner, Megan. *Is LEED a True Leader?*. p. 2

¹⁴⁶ Navarro, Mireya. *Some LEED Buildings Not Living Up to Green Label*. New York Times. (Aug. 2009)

¹⁴⁷ Turner, Megan. *Is LEED a True Leader?*. p. 2

¹⁴⁸ *Ibid*

Approach to Sustainable Building

While LEED-NC attempts to create sustainability within the built environment using primarily conservation, the LBC instead asks the question, “what if every single act of design and construction made the world a better place?”¹⁴⁹ By constantly posing this question, the LBC has determined that every intervention in the natural environment, including the construction of new buildings, should result in “greater biodiversity, increased soil health...and a deeper understanding of climate, culture and place.”¹⁵⁰ In other words, the LBC attempts to foster the idea that buildings should act as important parts of nature rather than as troublesome outsiders that should try to limit their impact on the natural environment as much as possible.

The LBC’s positive perspective on buildings’ role within the natural environment is noteworthy because it discourages the creation of impersonal green buildings. This being said, the LBC’s approach to sustainable building does not ask designers to make their buildings disappear into nature.¹⁵¹ Creating a living building simply involves making a structure an important and integrated feature of the landscape in which it is built. As architect Frank Lloyd Wright once said, “inside out – outside in, the environment and building are one,”¹⁵² this is essentially the goal of the LBC.

Benefits of the Living Building Challenge Over LEED-NC

As is evidenced by living buildings that have already been constructed, the LBC’s use of mandatory design Imperatives and generally positive approach to sustainable

¹⁴⁹ *Living Building Challenge version 2.0.*, p. 5

¹⁵⁰ *Ibid*, 5

¹⁵¹ Jodidio, Philip. *Architecture: Nature*. Prestel. p. 7

¹⁵² <http://greenplantsforgreenbuildings.org/attachments/wysiwyg/1/GPGBLEEDCreditNarrativeBiophilicConnection.pdf>

building encourages the construction of buildings that are healthier for human beings, more energy efficient, and more aesthetically pleasing than the buildings inspired by LEED-NC. I believe that this is primarily because the LBC requires the incorporation of biophilic design elements. Because of the LBC's inclusion of biophilic design elements within its certified buildings, the LBC is gaining popularity, as is evidenced by the growing number of projects requesting living building certification and by the fact that Living Building Institutes have already been established in the United States, Canada, Ireland, Mexico, and Australia.¹⁵³

Although the LBC and studies on biophilia make it evident that green building has the capability of creating positive and beneficial human-nature relations within the built environment, so far Pomona College's LEED-certified green building projects have failed to foster such interactions. An aesthetic analysis of Pomona College's green buildings, specifically the College's new Sontag and Pomona Residence Halls, reveals the reasons for this.

CH. 4- GREEN BUILDING AT POMONA COLLEGE- PAST AND PRESENT

Over the past decade, Pomona College's commitment to green building has grown exponentially. The creation of the President's Advisory Committee on Sustainability (PACS), Pomona's Green Building Standards, and the Pomona Sustainability Integration Office, have meant that sustainability, especially with regards to the built environment, has taken center stage. The College's landscape reflects this, as is exemplified by the

¹⁵³ <https://ilbi.org/countries>

LEED Silver certified Richard C. Seaver Biology building, the LEED Gold certified Lincoln-Edmunds buildings, and most recently the construction of the LEED Platinum certified Sontag and Pomona Residence Halls. Located in a line along 6th street, all of these buildings are filled with the best and newest energy and water-saving technologies. These LEED-NC certified buildings incorporate everything from dual-flush toilets to operable dual-pane windows to arrays of rooftop solar panels. In addition, each building has high-efficiency wall glazing, water-efficient landscaping, urban heat island reducing paving, CFL and LED lights with motion detection and daylight controls, and many more similarly impressive resource-saving technologies.

As with many other LEED-NC buildings, all three of Pomona's LEED-NC certified buildings incorporate characteristically Modern building elements in addition to having a great number of resource saving technologies. The buildings all have rectilinear shells, expansive windows, high ceilings, neutral colors, and large-scale air conditioning units. Meanwhile, each building uses "the chief materials of modern architecture: glass, concrete, steel, and plastics."¹⁵⁴ Given these design features, it is clear that all of these buildings, most especially the new Sontag and Pomona Residence Halls, stem from the modern building paradigm, which began at the turn of the 20th century.

Sontag and Pomona Residential Halls – An aesthetic appraisal

Exterior

Designed by architect Steven Ehrlich and his design team, the new Sontag and Pomona Residence Halls bear a strong resemblance to works done by other Modernist

¹⁵⁴ Yarwood, Doreen. *A Chronology of Western Architecture*. Facts on File Publications. (1987). p. 208

architects, such as the world renowned Le Corbusier. When examining the new residence halls, Le Corbusier's classically Modernist Unité d'Habitation in Marseilles, France (Figure 5)¹⁵⁵ comes to mind. In fact, Sontag and Pomona Residence Halls seem to revolve around a Le Corbusieran love of industry and technology; a fact expressed in the vast expanses of glass, concrete, metal, and other synthetic materials seen throughout the buildings' design.

Figure 5



Sontag and Pomona Halls' rectilinear shape, covered walkways, and vast amounts of glass also give the buildings a strong resemblance to the works of certain California-based modern architects, such as Richard Neutra, Rudolph Schindler, and Craig Ellwood. Neutra's Kaufmann House (Figure 6),¹⁵⁶ located in Palm Springs, California, employs a simple, functionally focused design, similar to the Sontag and Pomona Residence Halls, as each building was clearly designed with a specific purpose and set of occupants in mind. The residence halls' use of synthetic plastics, which have a metallic appearance, further supports this similarity.

¹⁵⁵ http://wiki-images.enotes.com/thumb/b/b3/Briey_unite_d_habitation.jpg/300px-Briey_unite_d_habitation.jpg

¹⁵⁶ <http://archpaper.com/news/articles.asp?id=1632>

Figure 6



Meanwhile, Sontag and Pomona Residence Halls' tan and brown color scheme, resembles the color scheme used by R.M. Schindler within his How House (Figure 7),¹⁵⁷ located in Silverlake, California. In addition, the new residence halls and Schindler's How House both use a great amount of reinforced concrete, one of the major building materials of classical Modernists, especially in California.

Figure 7



The visibility of so many aesthetically modern design elements within Sontag and Pomona Residence Halls is logical given that their architect, Steven Ehrlich, is a self-

¹⁵⁷ <http://allen1.typepad.com/blog/2010/01/rm-schindlers-how-house-1925.html>

titled “multicultural Modernist”¹⁵⁸ – a term Ehrlich uses to describe his “constant attempts to extend the traditions of architectural innovation and fuse technology with cultural and environmental sensitivity.”¹⁵⁹ Stemming from the California Modernist lineage, Ehrlich has a long history of using elements of the modern design style in new and innovative ways. His design of the Westwood Branch Public Library in West Los Angeles, along with his recently designed Walter Cronkite School of Journalism at Arizona State University in Phoenix, Arizona, are clearly 21st century modern architectural works created by a California Modernist. This is evidenced by both structures use of straight-line geometry and large amounts of reinforced steel and concrete.

Drawbacks of Modernism

Although Ehrlich’s use of modern design elements within the new Sontag and Pomona Residence Halls is understandable given his legacy as a designer, his stylistic decision brings with it two negative qualities that result from Modernism’s historically non-environmentally-focused ethos: the need for large-scale air conditioning and the use of the impersonal Machine aesthetic. Created during a time when energy, especially electricity, was cheap and plentiful, Modernism was a feasible and popular architectural style. Architects sought to use the freedom afforded to them by air conditioning to create sculptural pieces of architecture, which attempted to reconcile the principles underlying architectural design with rapid technological advancement and the modernization of society.

¹⁵⁸ Steven Ehrlich Architects. *Steven Ehrlich Architects: Multicultural Modernism*. The Master Architect Series. 2006. p. 26

¹⁵⁹ *Ibid*, Inner Flap

However, now that resource depletion and sustainability have become so important to every aspect of human life, including the building sector, society can no longer afford to build energy intensive structures if humanity is to begin to mitigate anthropogenic climate change. This poses, not incidentally, a serious challenge to Modernism's longstanding hold on the architectural imagination, especially within the field of green building.

Nonetheless, architects within the green-building movement continue to build using the Modern style. Steven Ehrlich is no exception to this tendency. His style revolves around layering abstracted cultural and ideological ideas and symbols, including sustainability, over a Modernist frame.¹⁶⁰ By weaving elements of particular cultures and ideologies into rectilinear Modernist shells, he has been able to design buildings that are aesthetically quite forward thinking from a classical Modernist perspective, such as that taken by Le Corbusier. However, Ehrlich's designs are still reflective of what environmentalists now understand to be an unsustainable building style. This calls into question both Pomona College's decision to hire Ehrlich for this project as well as Sontag and Pomona Residence Halls' publicized focus on sustainability.

Sustainable Details

Although Sontag and Pomona Residence Halls incorporate primarily Modernist qualities, because of Ehrlich and his team's concerted efforts to achieve a LEED certification of at least Silver, the new residence halls also include a number of sustainable design elements. Plentiful, drought-tolerant landscaping surrounds and

¹⁶⁰ Steven Ehrlich Architects. *Steven Ehrlich Architects: Multicultural Modernism*, p. 20

enlivens the residence halls. The six rows of massive solar panels (Figure 8)¹⁶¹ that rise above Sontag Hall's roofline also clearly indicate that the new residence halls are striving for some level of self-sufficiency in terms of energy use. Sontag Hall's rooftop garden is also quite obviously a sustainable feature. It acts not only as an energy saving "cool" roof, but also provides the buildings' occupants and visitors with pleasant views of the surrounding campus and the nearby San Gabriel Mountains. Although less obvious than other elements, the buildings' solar shades (Figure 9),¹⁶² which run horizontally along the outside of many portions of the residence halls' facades, are also a sustainable feature. They help diffuse direct incoming sunlight, making Sontag and Pomona Residence Halls less expensive to cool and light.

Figure 8



¹⁶¹ <http://www.pomona.edu/news/2011/03/23-new-residence-hall-photos.aspx>

¹⁶² *Ibid*

Figure 9



Upon closer examination of Sontag and Pomona Residence Halls, more green building features emerge, such as the use of textured and woodform concrete. The variety of small, shiny stones (Figure 10) encased within the buildings' main outer walls gives the man-made concrete material a more natural look. Likewise, the use of woodform concrete for the residence halls' numerous planter boxes (Figure 11) imbues the otherwise plain concrete plant holders with pleasant organic patterns.

Figure 10

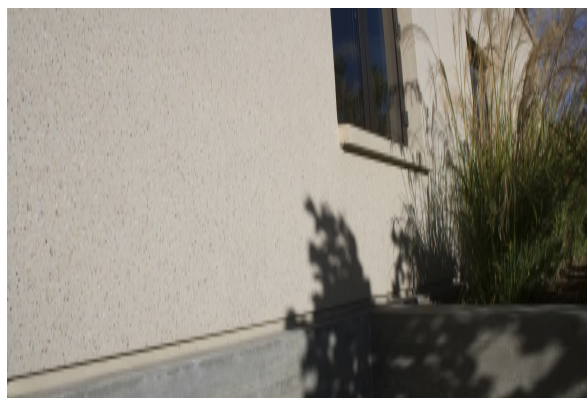


Figure 11



Sustainability Beneath the Surface

Ehrlich and his design team's efforts at creating sustainability go deeper than Sontag and Pomona Residence Halls' exterior. In an interview with Charles "Duke" Oakley, one of Elrich's Design Principals, Oakley stated that "sustainability drove the design [of Sontag and Pomona Residence Halls]."¹⁶³ Specifically, Oakley pointed to the firms' extensive use of concrete within the new Pomona College structures, which is designed to mimic the Anasazi building method wherein structures are created with a large thermal mass.¹⁶⁴ By constructing Sontag and Pomona Residence Halls using primarily concrete,¹⁶⁵ Oakley and Ehrlich attempted to design the new buildings to better deal with Southern California's hot summers and large diurnal temperature changes.¹⁶⁶ This effort, combined with the frequent absence of breezes within the area surrounding Pomona College, made Oakley and Ehrlich's decision to focus on thermal mass sensible

¹⁶³ Interview with Charles "Duke" Oakley, October 6th, 2011

¹⁶⁴ *Ibid*

¹⁶⁵ According to Oakley, the new residence halls' walls consist of an outer shell of pre-cast concrete, a sandwich of Styrofoam insulation, and an inner layer of pre-cast concrete.

¹⁶⁶ Interview with Charles "Duke" Oakley, October 6th, 2011

and sustainable in the long run, as it means less energy will be required to heat and cool the new residence halls.

Oakley and Ehrlich also took great care to incorporate an innovative storm-water runoff system within the new residence halls' design. Both structures' are equipped with a system that collects precipitation that lands on the buildings' roofs and funnels it to the nearby environmentally sensitive area known as "the Wash."¹⁶⁷ Once within "the Wash," the storm water slowly percolates through layers of soil before eventually recharging the local aquifer located beneath Pomona College.¹⁶⁸

Ehrlich and his team also designed the buildings with electronic screens that display the buildings' daily energy, water, gas, and electricity usage as well as solar panel energy production. While there are only two of these small-television-sized screens, they are placed at the residence halls' two most popular entrances. This placement maximizes their visibility to students and visitors.

It should also be noted that Ehrlich and his team wished to incorporate a "night flush" ventilation system within the new residence halls' design.¹⁶⁹ This "night flush" would have consisted of students opening their windows at a specified time during the evening, while the residence halls' ventilation system sucked in cold night air from the outdoors.¹⁷⁰ By installing this "night flush" feature, Ehrlich and his team predicted that Sontag and Pomona Residence Halls would have increased their energy savings by 3% over the currently in-place model.¹⁷¹ Furthermore, employing this new design strategy would have better involved students in the new residence halls' efforts at sustainability; a

¹⁶⁷ *Ibid*

¹⁶⁸ *Ibid*

¹⁶⁹ *Ibid*

¹⁷⁰ *Ibid*

¹⁷¹ *Ibid*

fact that would have likely increased these students' sustainable habits and potentially deepened their relationship to the surrounding natural environment. However, members of the Sontag and Pomona Residence Halls' design task force, which included members of the Pomona College maintenance staff, alumni, and Pomona College students, were skeptical of students' willingness to participate¹⁷² within the new design (which needed at least an 80% participation rate to work as modeled)¹⁷³ and voted the design down.

Modernistic Design's Shielding Effect

According to architectural critic and author Reyner Banham, "environmental provisions have only attracted attention when they have made some gross monumental impact on the exterior aspect of buildings."¹⁷⁴ While there are certainly some sustainable elements that are visible from Sontag and Pomona Residence Halls' exterior, these elements tend to recede into the background of an otherwise Modernist design. The residence halls' storm water collection system is a perfect example of this pattern.

The only signs of this innovative system are two dozen narrow, iron pipes running vertically down the sides of the new residence halls and stopping just above one-by-one foot metal grates embedded in the ground. Due to Pomona and Sontag Residence Halls' linear design, these pipes blend in with the buildings' structure and go unnoticed by the vast majority of passersby and occupants. This fact is supported by data from this thesis' administered survey, in which over 70 percent of surveyed students claimed to have never noticed or even known about the storm system's pipes.¹⁷⁵

¹⁷² *Ibid*

¹⁷³ *Ibid*

¹⁷⁴ Banham, Reyner. *The Architecture of the Well-Tempered Environment*. p. 12

¹⁷⁵ See Appendix 2 for student survey data

Ehrlich and his team's efforts to construct the new residence halls with a large thermal mass were also praiseworthy, yet not clearly visible. Because all occupants and visitors see when looking at Sontag and Pomona Residence Halls is concrete, which is a historically Modernist building material used within many historically unsustainable building projects, people do not know that the residence halls were designed with sustainability as a central goal. This is reflected within this thesis' survey data in which almost half of surveyed students reported that the new residence halls' aesthetics make the buildings appear only "average" in terms of sustainability.¹⁷⁶ One student even commented that he or she only knew the new residence halls were sustainable due to the signage within the building. If the architects had used an organic, thermally stable material, such as adobe, which has been shown to be an effective building material for creating high thermal mass,¹⁷⁷ the new residence halls' thermal mass design feature may not have gone unnoticed by the majority of Sontag and Pomona Residence Halls' occupants.

Need For Clear Environmental Aesthetics

Instead of designing Sontag and Pomona Residence Halls to function sustainably, yet have the appearance of buildings from a historically unsustainable era, Steven Ehrlich and his design team would have been better served by displaying their design's sustainable elements in a more obvious manner, such as through the use of biophilic design elements. By clearly highlighting Sontag and Pomona Residence Halls' sustainable features on the buildings' exteriors, these new residence halls would better act

¹⁷⁶ See Appendix 2 for student survey data

¹⁷⁷ <http://www.buildingwithawareness.com/house1.html>

as a repository for Pomona College’s sustainable goals and ideals. Furthermore, with a different structural design, these buildings would also better inspire the people who interact with them to realize that human beings and their built structures can be a positive part of the natural world, not just negatives that must be minimized.

Art critic John Rashkin proposed that we ask two things of our buildings: “we want them to shelter us” and “we want them to speak to us of whatever we find important and need to be reminded of.”¹⁷⁸ Sontag and Pomona Residence Halls accomplish Rashkin’s first task, yet fail to adequately accomplish the second. By more obviously incorporating biophilic design elements, like organic materials and design shapes, into the new residence halls, Ehrlich and his team would have made these new buildings’ sustainable goals nearly impossible to miss. However, as of now Sontag and Pomona Residence Halls’ likeness to the historically unsustainable Modernistic aesthetic, combined with the fact that many of the new buildings’ sustainability-oriented details are only visible from close up, makes the new residence halls appear like unsustainable structures trying to feign environmental consciousness through the display of token energy- and water-efficiency technologies and landscaping.

Default Green Building

Unfortunately, the design of Sontag and Pomona Residence Halls represents a common pattern within the green building industry. According to art critic Kriston Capps, many LEED buildings have a “default ‘green’ look to them: blocky, all glass, and covered in matted foliage.”¹⁷⁹ Capps argues that the amount of default green building “is

¹⁷⁸ Banham, Reyner. *The Architecture of the Well-Tempered Environment*. p. 62

¹⁷⁹ Capps, Kriston. *Green Building Blues*. The American Prospect. (Feb. 12, 2009)

growing partly because high designers and the so-called ‘starchitects,’ who fear that new methods and materials might not comport with long-established styles, are not taking the lead on sustainability issues, leaving green innovation to younger firms with fewer resources.”¹⁸⁰ In addition, Capps believes that both “well-known firms and up-and-comers lack experience working with new, often expensive green materials, which has forced many designers to depend greatly on singular and design-restrictive tactics”¹⁸¹ to achieve sustainability goals.

Famous architects’ lack of interest in green buildings has allowed “digital architecture” to take over the green-building sector. The most famous international green building standards, such as LEED-NC and the Passive House Building Energy standards,¹⁸² have come to rely almost completely on the use of computer modeling and simulation to create their designs. Specifically, the creation of energy modeling – which is the process of using computer models to analyze a building's energy-related features to project its energy consumption – has greatly affected much of contemporary green design. Because of energy modeling, many sustainable building projects now revolve around what the best new synthetic technology for a certain aspect of a building’s design is or what room shape would make it easiest to predict the necessary energy required to keep a room at the right temperature. In other words, similar to normal contemporary

¹⁸⁰ *Ibid*

¹⁸¹ *Ibid*

¹⁸² The Passive House Building Energy standards revolve around a comprehensive building system designed to create a very well-insulated, virtually air-tight building that is primarily heated by passive solar gain and by internal gains from people, electrical equipment, etc. The Passive House Building Energy standards were created by the Passive House Institute, a 501c(3) nonprofit organization that provides training, education and research to promote the implementation of Passive House Building Energy standards.

building, green building has become more a matter of determining how to best heat and cool space rather than how to best heat and cool people.

This is evidenced by the new Sontag and Pomona Residence Halls, which were constructed using the help of CTG Energetics Inc., a consulting firm that specializes in energy modeling and LEED implementation.¹⁸³ Ehrlich and his team hired CTG Energetics Inc. to conduct an in-depth energy modeling of the new Sontag and Pomona Residence Halls to determine what design option would be best in terms of energy efficiency and cost. To help with this decision process, CTG Energetics Inc. created a “Schematic Design Energy Analysis Report.” This report, which I was privileged to view as a result of my interview with Duke Oakley, used eQuest (version 3.61e) to conduct a whole-building analysis in which CTG Energetics “calculate[d] the heating and cooling loads and the [new residence halls’] energy usage for each hour of the year.”¹⁸⁴ This in-depth Analysis Report also included energy rate costs based on local utility rates, such as the “Southern California Edison GS-2TOU rate for electricity and the Southern California Gas Company GN-10 rate for natural gas.”¹⁸⁵ Finally, the Analysis Report included a detailed description of the possible energy savings that would come from implementing a variety of energy efficiency technologies and measures, such as high performance fenestration, exterior window shading, hybrid mechanical controls, and increased ventilation openings to facilitate natural ventilation in all spaces.¹⁸⁶ As is evident from the CTG Energetics-produced report, Sontag and Pomona Residence Halls exemplify the effects of the new digital architecture revolution within green building.

¹⁸³ <http://www.ctg-net.com/energetics/WhatWeDo.aspx>

¹⁸⁴ CTG Energetics, Inc. *Pomona College North Campus Residence Hall Schematic Design Energy Analysis Report*. July 15th, 2008 p. 4

¹⁸⁵ *Ibid*, 4

¹⁸⁶ *Ibid*, 10

Because of digital architecture's new dominance over green building, many new sustainable buildings' interiors have some of the same qualities as computer-modeled modern buildings. This fact also holds true for the Sontag and Pomona Residence Halls where similar to many modern buildings, the "need for air conditioning has literally been set in concrete and steel."¹⁸⁷

Interiors

Sontag and Pomona Halls' interiors consist primarily of student living spaces, which are set up as suites with 3-, 4-, 5- and 6-bed configurations, a shared bathroom, and common living rooms and kitchenettes.¹⁸⁸ Each floor of each building has a full kitchen and family-style lounge, as well as a room for trash and recycling. Pomona Hall also houses a large public lounge and kitchen, and the new Outdoor Solar Panel Education Center (located on the roof).¹⁸⁹

To enter the new residence halls, occupants must enter two sets of heavy, black, automatic entrance doors, both of which require security card access. Because of the doors' weight and color, the buildings seem to be protecting themselves from intruders, both human and those made by nature. According to writer and chief inspiration behind the new Living Architecture project,¹⁹⁰ Alain De Botton, it is important to consider human beings' "unconscious detection of parallels to themselves within architecture,"¹⁹¹

¹⁸⁷ Cox, Stan. *Losing Our Cool: Uncomfortable Truths About Our Air-Conditioned World (and Finding New Ways to Get Through the Summer)*. p. 198

¹⁸⁸ <http://www.pomona.edu/news/2011/03/23-new-residence-hall-photos.aspx>

¹⁸⁹ *Ibid*

¹⁹⁰ The Living Architecture Project is a new social enterprise that was created to offer people a chance to rent houses for a holiday designed by some of the most talented architects at work today, and set in some of the most stunning locations in Britain.

¹⁹¹ De Botton, Alain. *The Architecture of Happiness*. Vintage International. 2006. p.89

as well as their “ability to interpret a character from the humblest shape”¹⁹² when creating new structures. Architects, especially those designing green buildings, must remember De Botton’s words, as design elements of all sizes can greatly influence certain types of behavior within buildings. This fact is true within the new residence halls, where the entrance doors should be altered so as to make the buildings more porous to the surrounding natural environment, thus encouraging more positive interactions between occupants and nature.

Once through the entrance doors, the elevator lobby area in the new residence halls is pleasant due to a cluster of locally gathered rocks (Figure 12), which are located underneath the staircases leading to the buildings’ upper floors. These rocks are one of the few biophilic design elements within the entirety of the new residence halls, as they remind occupants and visitors of where Sontag and Pomona Residence Halls are located within the world. However, due to the rocks’ location beneath the stairs, occupants have little to no physical interaction with them, as the rocks’ presence is relegated to a symbolic gesture. With a different placement however, such as within the main lounge area,¹⁹³ students would be able to better touch, climb on, and enjoy these rocks as active, biophilic design features of the new residence halls.

¹⁹² *Ibid*, 89

¹⁹³ It should be noted that this new placement of rocks would be done with the intention of creating increased biophilia, yet would still keep students and visitors safe. In other words, rocks would likely be glued in place and/or to one another so as to prevent students from being tempted to pick up, take, or use the rocks to cause injury to one another or destruction to the new residence halls.

Figure 12



Moving past the buildings' elevators, the large public lounge areas take center stage. Within Pomona Hall, the large public lounge integrates a combination of design elements that give it the feel of a Japanese-style pavilion. The lounge's soaring two-story height, combined with its hanging, rice-paper-style lanterns and its series of narrow, wooden ceiling beams (Figure 13), activate and visually unify the large space in a way commonly seen in many modern Japanese structures. This design is well executed, even if it does not necessarily reflect Pomona College's sustainable ideals as stated within the College's Sustainability Action Plan.¹⁹⁴

¹⁹⁴ As of now, the Pomona College Sustainability Action Plan includes seven main goals: Reduced greenhouse gas emissions, Reduced resource impact, Reduced air, water, and soil pollution and toxins, Increased environmental health for all members of the community, Sustainable sustainability, Public commitment to sustainability.
<http://www.pomona.edu/administration/sustainability/action-plan/goals.aspx>

Figure 13



In addition to the overhead woodwork, two out of the lounge's four sides are large, windowed facades, which serve to let through a great deal of light during the daytime hours. These floor-to-ceiling windows (Figure 14) also enable occupants to gaze out at the surrounding landscape and passing people. However, while the lounge provides pleasant natural lighting and views of the outside, the enjoyable feeling one gets while sitting in this space is tempered by the mechanical background noise that is constantly present. Because the loud, mechanical humming of the HVAC¹⁹⁵ units is most noticeable in this central area of Pomona Hall, it takes little effort for occupants of this room to remember that they are inside and nature is outside. This is reflected in the fact that over one-third of surveyed students' feel that the new residence halls do not encourage positive interactions between human beings and nature.¹⁹⁶ Specifically, students noted that the buildings inhibit person-to-person contact do not adequately encourage positive interactions between students and the surrounding natural landscaping or rooftop garden.

¹⁹⁵ HVAC: Heating Ventilation and Cooling

¹⁹⁶ See Appendix 2 for student survey data

Figure 14



Moving out of the lounge area towards the Pomona Hall's living quarters affords one a view of the building's hotel-like hallways, a style that is also seen within Sontag Hall's hallways. Within each hallway, the uniform design of the carpets (Figure 15) and layout makes every floor of both buildings look almost identical, save for the differing paint colors on the walls. This general uniformity, an aspect that is commonly seen within many Modern buildings due to their goals of simplicity and functionality, causes Sontag and Pomona Residence Halls' to lack character and intrigue. This lack of mystery is exacerbated by the fact that there are no bends, curves, or irregular shapes within the structure.

Figure 15



The hallways do possess certain nicely designed features, such as the wooden strips on the ceiling (Figure 16), which run outward from the central lounges. These bits of organic material, which are strongly reminiscent of the wood used for Craig Elwood's 1953 Johnson House in Brentwood, California (Figure 17),¹⁹⁷ help to enliven the muted hallways. However, just as in the main lounges the loudness of the ever-present mechanical HVAC system neutralizes the wooden strips' pleasant effect.

Figure 16



Figure 17

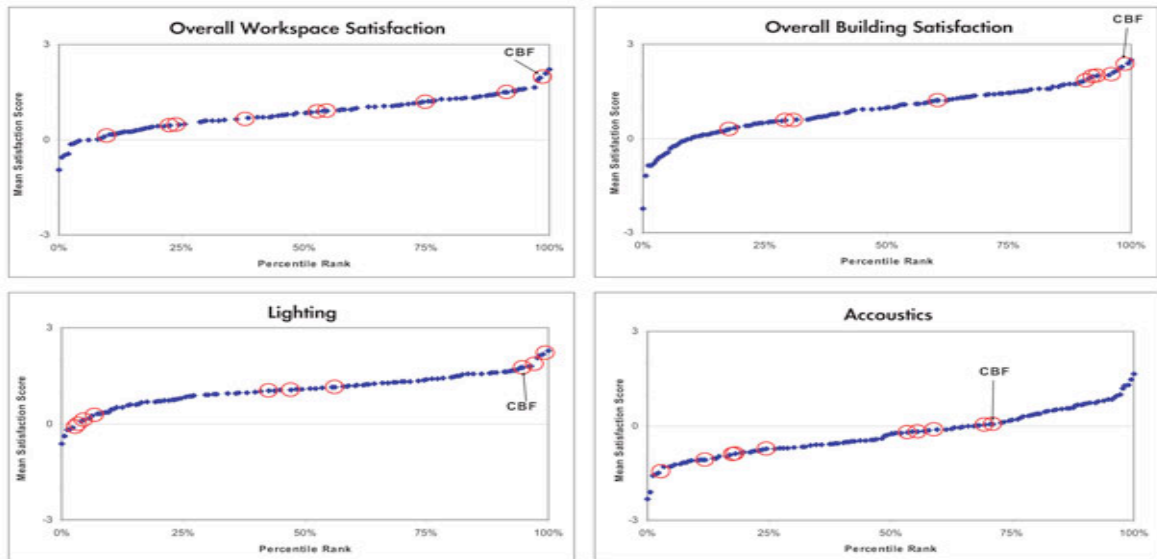


¹⁹⁷ <http://archpaper.com/news/articles.asp?id=1632>

Within the students' suites and rooms, one continues to feel the HVAC units' presence, although it is possible to quiet the system by opening one of the suite's windows. In addition to the acoustic difficulties in the living room and bedroom areas of each suite, it is also difficult to acclimate to the acoustics within the windowless bathroom and shower rooms. The poor acoustics seen throughout these new residence halls reflects a common, well-documented pattern within LEED-NC certified buildings. A study (Figure 18) conducted by the Center for the Built Environment (CBC), in which 180 LEED building projects were examined, confirms that "occupants rate the air quality and thermal comfort of their LEED buildings quite highly but feel mixed about the lighting and are generally dissatisfied with the acoustics."¹⁹⁸

Figure 18

Satisfaction Score Distributions at LEED and Non-LEED Buildings



¹⁹⁸ <http://www.buildinggreen.com/auth/article.cfm/2005/6/1/Occupant-Satisfaction-with-LEED-Buildings-A-First-Glimpse/>

Such feelings are partially confirmed by this thesis' administered survey, wherein over one-third of students were dissatisfied with the amount of lighting in their suites, while a little under one-quarter of students reported that the new residence halls' acoustics were a detractor to their comfort.²⁰⁰ In particular, students claimed that there was not enough light in their suites and that some walls were noticeably less sound proof than others.

Important Admonitions

Although it is clear that elements of the new Sontag and Pomona Residence Halls could be improved, it is important to note three admonitions regarding the above critique of their current form. To begin with, designing buildings large enough to safely house the same amount of occupants currently living in the new residence halls (~150) using a type of architectural design other than Modernism would be quite difficult. However, employing a different type of architectural style, such as natural building,²⁰¹ would not have been impossible.

By combining contemporary building technology with natural building techniques and materials, Ehrlich and his design team could have created organically designed buildings that also integrated natural features, such as running water or living organisms.

¹⁹⁹ *Ibid*

²⁰⁰ See Appendix 2 for student survey data

²⁰¹ Natural building techniques use non-industrial, local, renewable materials to construct buildings that are appropriate for their geographic locations while using as few resources as possible. Natural building also focuses on building's architectural design elements, such as the building's orientation and ventilation, as well as on-site treatment of water and waste.

For example, Frank Lloyd Wright’s use of running water within his Fallingwater residence (Figure 19)²⁰², located in Mill Run, Pennsylvania, demonstrates that it is possible to construct good-sized, habitable buildings that integrate natural elements directly into their design.

Figure 19



Likewise, the vertical gardens at the Musée du Quai Branly (Figure 20)²⁰³ in Paris, France and the Ann Demeulemeester Shop (Figure 21)²⁰⁴ in Seoul, South Korea, demonstrate how large, safely constructed buildings can communicate sustainability through their aesthetics. Meanwhile, Edouard Francois’ “Flower Tower” (Figure 22),²⁰⁵ also located in Paris, demonstrates that it is possible to add living organisms to Modernistic architecture to create a building that is more clearly concerned with sustainability and its effects on the natural environment. Finally, models for the first

²⁰² <http://www.wright-house.com/frank-lloyd-wright/fallingwater-pictures/F1SW-fallingwater-in-fall.html>

²⁰³ <http://inhabitat.com/wp-content/blogs.dir/1/files/2010/09/flower-tower.jpg>

²⁰⁴ http://mimoa.eu/images/905_1.jpg

²⁰⁵ <http://coolboom.net/en/wp-content/uploads/2008/01/ann-demeulemeester-shop1.jpg>

commercial "super adobe" building (Figure 23)²⁰⁶ in the United States, which is being constructed by the Claremont Environmental Design Group within a mile of the Pomona College campus, demonstrates that it is possible for natural building methods to be used for large-scale building projects.

Figure 20



Figure 21

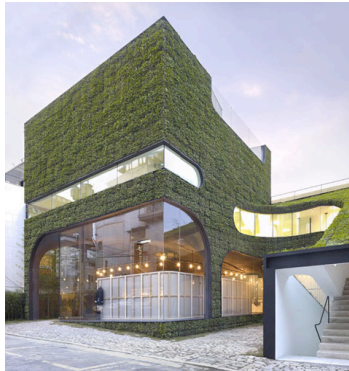


Figure 22



²⁰⁶ <http://uncommongood.org/>

Figure 23



It is also important to temper the above critique of the Sontag and Pomona Residence Halls by noting that a complete discarding of all Modern design elements is not necessary to successfully creating sustainable buildings with environmental aesthetics. There are some benefits to designing green buildings using certain Modernistic elements. For example, Modern building's flat roof design works quite well for solar panel installations. Additionally, Modernism's use of new building technology and materials enables the construction of massive, structurally stable windows, which allow a great deal of natural lighting to enter a building as well as provide occupants with views of the outdoors. Given their beneficial effects, these design features are worth keeping and employing under certain circumstances within later green buildings.

The third important issue to address while critiquing Sontag and Pomona Residence Halls' structural design is their age. Like many other newly completed buildings, the new residence halls have little character, which can often be interpreted as starkness. With more time and more residents living in these new buildings however, Sontag and Pomona Residence Halls will likely gain more character and more personality. This fact will lighten the starkness of their Modern design, especially their interiors, and make them less impersonal overall.

However, while this natural accumulation of character will be beneficial for the new residence halls, installing biophilic design elements within Sontag and Pomona Residence Halls will greatly decrease the time during which the new residence halls lack character. Furthermore, incorporating more biophilia within the new residence halls will also add a different and potentially more valuable type of character to these buildings that won't simply occur on its own.

Energy Efficiency

Pomona's green buildings have a tendency to be less energy efficient than predicted. While there is no available data for the Richard C. Seaver Biology building, Megan Turner demonstrated that there is a large disparity between the Lincoln-Edmunds buildings' actual and predicted energy efficiency performance. According to Turner, "even in the first year after the building was built, during which it was only partially occupied, Lincoln-Edmunds used more energy than its Title-24 baseline allotment."²⁰⁷ Specifically, the Lincoln-Edmunds buildings "performed [only] 38.9% better than Title-24 energy efficiency requirements"²⁰⁸ even though the buildings were supposed to have "a predicted energy savings of 52.6% over Title-24."²⁰⁹ In other words, even after being "awarded 10 out of 10 points [of LEED-NC credit] for optimizing energy performance,"²¹⁰ Lincoln-Edmunds "was already using nearly twice as much [energy] as projected."²¹¹ Furthermore, Turner notes that Lincoln-Edmunds' "energy use has only

²⁰⁷ Turner, Megan. *Is LEED a True Leader?*. p. 42

²⁰⁸ *Ibid*, 42

²⁰⁹ *Ibid*, 42

²¹⁰ *Ibid*, 42

²¹¹ *Ibid*, 43

grown since [its construction], reaching nearly three times the projected usage and almost twice the Title-24 budget during the 2008-2009 school year.”²¹²

Currently, only three months of energy data are available for the new Sontag and Pomona Residence Halls. But given the track record of the Lincoln-Edmunds buildings, it may be that these new residence halls will also not perform as energy efficiently as expected.²¹³ If it occurs, this disparity will be due primarily to the vagaries associated with energy modeling.

Energy Modeling

Focusing a new building’s design around energy modeling—as Pomona and Sontag Residence Halls were—has a number of pitfalls. Along with creating incentives for architects to design aesthetically Modern, unsustainable looking buildings, using energy modeling oftentimes fails to accurately calculate occupant behavior and equipment malfunction frequency. One of the most common errors associated with energy modeling is “the use of unrealistic assumptions regarding human behavior within buildings.”²¹⁴ Specifically, the actual occupancy hours can differ from those used in the initial design assumptions.²¹⁵

It has also been shown that many designers are oftentimes “optimistic about the behavior of occupants and their acceptance of in-place climate control systems.”²¹⁶ Because of this, design elements, such as automatic light sensors and the use of air conditioning can

²¹² *Ibid*, 43

²¹³ As of now, Sontag and Pomona Residence Halls are predicted to perform “49.2% better than the ASHRAE 90.1-2004 Standard” according to the CTG Energetics Energy Analysis Report.

²¹⁴ Birt, B. & Newsham, G.R. *Post-occupancy evaluation of energy and indoor environment quality in green buildings: a review*. (June 2009). p. 3

²¹⁵ *Ibid*, 3

²¹⁶ *Ibid*, 2

fail to perform as efficiently as predicted. Additionally, it has been shown that “certain experimental technologies proposed to save energy may not perform as predicted.”²¹⁷

This is an important factor to consider within the new residence halls, as much of the porous concrete materials used within the buildings’ design have not been used in many other structures. Finally, “plug loads are often very different than assumed”²¹⁸ during the energy modeling process. This fact is important to take into account, as a miscalculation in plug loads can significantly change the energy use of a building.

While it may be more difficult to use energy modeling to design buildings in terms of actual human needs, it is necessary if green builders are to ensure greater positive interaction between occupants and the structures those occupants are living in. By constructing the proper type of environment within a building, designers will be able to positively affect occupants’ behavior and potentially make it more sustainable. As Winston Churchill said, “we shape our buildings, and afterwards our buildings shape us.”²¹⁹

Moving Forward

The fact that Pomona College’s initial LEED-NC certified buildings use aesthetics associated with what many would consider unsustainable building practices, and the fact that these buildings may prove somewhat less energy-efficient than predicted, suggests why the LEED-NC rating system should be changed to include guidelines concerning more stringent energy efficiency policies, more clear environmental aesthetics, and more biophilia. Some may argue that LEED-NC should not

²¹⁷ *Ibid*, 3

²¹⁸ *Ibid*, 3

²¹⁹ <http://www.winstonchurchill.org/learn/speeches/quotations>

be held responsible for the design of the new Sontag and Pomona Residence Halls. To some degree, this is true given that the buildings were designed by Steven Ehrlich, a Modernist architect, and commissioned by Pomona College, an institution with no affiliation to the USGBC. However, because the LEED-NC system touts Sontag and Pomona Residence Halls as structures worthy of the highest praise from green architects, much of the blame must still rest on it.

While LEED-NC has been altered in its latest version 3,²²⁰ the revised standards still fail to incorporate as much about biophilia, environmental aesthetics, and demonstrated energy efficiency as is necessary to ensure successfully sustainable buildings in the long run. Given this fact, Pomona College should strongly consider constructing and renovating its buildings according to a different set of green building standards in future years. Based on its biophilia-infused guidelines and the built structures it has inspired thus far, the Living Building Challenge appears to be the best available choice for Pomona College.

By using the LBC standards in tandem with Stephen Kellert's writings on biophilic design, I propose that Pomona College can modify Sontag and Pomona Residence Halls to increase the amount of positive human-nature interaction between occupants of the new residence halls and the surrounding natural environment in which the buildings are located. Furthermore, I believe that focusing on incorporating both organic and vernacular biophilic design elements within the new residence halls will make the buildings more visibly sustainable, a fact that will foster greater environmental stewardship within the Pomona College community. What follows are a few possible ways to incorporate some of these biophilic design elements within Sontag and Pomona

²²⁰ LEED-NC was launched on April 27, 2009.

Residence Halls, as well as Pomona College's future green building projects, using the principles of restorative environmental design.

CH. 5 – RECOMMENDED ALTERATIONS TO THE NEW RESIDENCE HALLS

*Exteriors*²²¹

Vegetative Facades

According to Stephen Kellert, buildings with vegetative facades, such as ivy walls or green roofs, often “provoke interest and satisfaction in human beings.”²²² Kellert believes this likely reflects “the historic benefits associated with organic materials as sources of insulation and camouflaging protection.”²²³ The use of green facades could be applied quite successfully to Sontag and Pomona Residence Halls given the buildings’ large, currently unadorned exterior walls. By covering all (or even just a few) sides of the new residence halls with some sort of visible vegetation (Figures 24 & 25), Pomona College could infuse these buildings with more biophilia, dramatically improve their environmental aesthetics, improve their character, as well as better integrate them into the natural environment in which they are located.

²²¹ Given that the Sontag and Pomona Residence Halls are newly finished buildings that cost Pomona College a great deal of money to construct, the following recommendations seek to work with the buildings in their current form. In other words, in an effort to be as realistic as possible, the following recommendations do not ask for a complete overhaul of the building’s structural design, even though this would be called for to optimize the new residence halls according to the principles of biophilic design.

²²² Kellert, Stephen. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*. (2008).

²²³ *Ibid*

Figure 24



Figure 25



Improved Environmental Aesthetics

Some may argue that Sontag and Pomona Residence Halls' surrounding native landscaping already provides enough greenery to communicate the new residence halls' sustainable focus. However, I believe this is not the case, as currently the new residence halls' landscaping only appears to be covering up their "average"-looking sustainable

aesthetics (according to surveyed students).²²⁴ In an effort to overcome students' current lukewarm feelings toward Sontag and Pomona Residence Halls it appears necessary to add more visible greenery to the buildings' exteriors.

The addition of organic vegetation would lend a dynamic, quasi-living character to the new residence halls. Creating this living character would serve to partially offset Sontag and Pomona Residence Halls' impersonal look and agelessness, both of which are by-products of the new residence halls' great deal of visible cement. According to Kellert, the "dynamic progression of aging evokes a sense of familiarity and satisfaction among people, despite the eventual occurrence of senescence, death, and decay."²²⁵ In contrast, Kellert posits that because of artificial and synthetic products' lack of aging, "they rarely evoke a sustained positive response from people even when the products are exact copies of elements found in the natural environment."²²⁶ It is for this reason that the addition of visible, living plant matter to Sontag and Pomona Residence Halls is so important, as it will imbue these buildings with the concepts of age and time.

The importance of making building's aging process visible can be seen within many of Pomona College's older dorms, such as Norton-Clark and Clark III (Figures 26 & 27). These dorms, which were both constructed in the 1950s, clearly bear the marks of time and frequent use. However, because Norton-Clark and Clark III were designed using the classic Spanish California Colonial style, which uses a combination of sturdy stucco and organic adobe brick, they have aged quite well. As a result, Norton-Clark and Clark

²²⁴ See Appendix 2

²²⁵ Kellert, Stephen. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*. (2008)

²²⁶ *Ibid*

III have steadily increased in character over the years, all while maintaining much of their beauty and preserving a feeling of comfort and livability.

Figure 26



Figure 27



Better Advertising of Sustainable Features

Altering Sontag and Pomona Residence Halls using a green facade would also make the new residence halls' sustainable goals more clear, as it would likely lead to greater student and visitor recognition of the buildings' sustainable features. For example, Pomona College could create patterns with the new façade vegetation to highlight the new residence halls' storm water collection system (Figure 28). By having a group of

flowers or different colored succulents running alongside some of the storm water system's pipes, it would be possible to raise awareness for the innovative way in which Sontag and Pomona Residence Halls harvest the storm water that land on them and channel it down to the local aquifer located beneath Pomona College. Advertising the new residence halls' sustainable features in such a manner would likely inspire students to reexamine their current habits and begin (or at least consider) changing them to be more sustainable.

Figure 28



Increased Place-Based Relationships

Within his book, *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*, Kellert posits that “plants on buildings can evoke a powerful vernacular or sense of place.”²²⁷ By covering parts of Sontag and Pomona Residence Halls' exteriors with native plants, such as succulents or desert flowers, the new residence halls could become more identifiable as buildings constructed within the Inland Empire's desert

²²⁷ *Ibid*

ecosystem. Furthermore, using native plants would be the most cost-effective way to give the new residence halls a green façade given native plants' minimal water requirements.

Outfitting the new residence halls with green facades would also enable Pomona College to begin counteracting the rapidly increasing practice of constructing placeless buildings.²²⁸ “Advanced techniques and materials, as well as transport and communication links, have allowed the appropriation of Modernist concepts and a universal architectural language throughout most, if not all, of the world.”²²⁹ This pattern can now be seen within many modern universities, where “a hodgepodge of architectural styles often clash with the vocabulary of historic quads.”²³⁰ As of now, Sontag and Pomona Residence Halls are parts of this growing trend. However, by adding more prominently visible environmental features that relate to the Inland Empire, Pomona College can give Sontag and Pomona Residence Halls a better sense of place and knit them into the already cohesive Pomona College landscape.

Better Integration into the Surrounding Ecosystem

By using façade greening, Pomona College will increase the new residence halls' tie with the surrounding natural environment. If Pomona College covered a great deal of Sontag and Pomona Residence Halls' exteriors with native plants, the new residence halls could begin to attract a great deal of pleasant local wildlife, such as hummingbirds, bees,

²²⁸ A “placeless building” is a term used by many scholars to refer to a building's weakening of distinct and diverse experiences and identities of place. In other words, the idea of placelessness refers to the idea that whatever is being discussed, be it a building or a suburban development, could be located anywhere given its aesthetics.

²²⁹ Fry, Michael. *Globalisation and 'Placeless' Architecture*. (Nov. 2010). p. 1

²³⁰ McDonough, William, Braungart, Michael, & Dale, Diane. *A Building Like A Tree, A Campus Like A Forest: Sustainable Design, Ecological Literacy, and the Legacy of the New England Campus*. (2002). http://www.mcdonough.com/writings/building_like_tree.htm

and butterflies. Taking on this new role as a wildlife habitat would enliven the new residence halls and move them one step closer to becoming more positive, valuable, and integral parts of the ecosystem in which Pomona College is located.

According to Kellert, “buildings and landscapes that possess a close and compatible relationship to local habitats and ecosystems tend to be highly effective and preferred by human beings.”²³¹ This fact would be especially true at Pomona College where many students are growing more and more concerned with issues regarding the natural environment, a fact that is evidenced by the large amount of Environmental Analysis Majors (whose numbers have grown such that Environmental Analysis is the 3rd most popular major at Pomona College)²³² and the growing number of students involved in on-campus sustainability groups, such as PEAR.²³³

Cost

Installing and maintaining green facades can be quite expensive.²³⁴ Given this fact, it is acceptable (although not advised) for Pomona College to substitute green facades for manmade natural shapes and forms, such as botanical motifs or murals. While using living vegetation is optimal given its aforementioned qualities, I believe that adding

²³¹ Kellert, Stephen. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*. (2008)

²³² Figures given by Richard Hazlett, Former Head of Pomona College’s Environmental Analysis Department

²³³ PEAR: Pomona for Environmental Activism and Responsibility

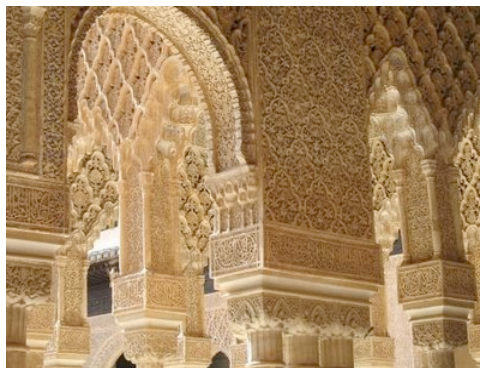
²³⁴ For general budgetary purposes, a typical manufactured material-only cost for a living wall (stainless rails and framesets, recycled modules) can be expected to cost approximately \$60 to \$90 per square foot, depending upon the scale of the installation. The “all-in” cost, including plants, soil, irrigation, and installation, may result in twice the manufactured material only amount. For example, the Marketplace at Oviedo project, which spanned 105,175 sq. ft., the total cost was \$426,000 for 100,175 sq. ft. (Sources:

http://www.greenroofs.net/components/com_lms/flash/Green%20Walls%20Intro%20908b.pdf & <http://continuingeducation.construction.com/article.php?L=260&C=808&P=4>)

natural motifs and murals to Sontag and Pomona Residence Halls' exteriors will still improve the buildings' aesthetics. This is evidenced by the success of the patterns and wall motifs used in the Alhambra located in Grenada, Spain (Figure 29).²³⁵

The Alhambra's beautifully flowing arabesque and floral motifs, which can be seen primarily within the building's interior, give the Alhambra natural, serene, and peaceful qualities. Using the Alhambra as a guide, Pomona College could transfer certain ideas and designs, at least conceptually, to Sontag and Pomona Residence Halls' exteriors. By adding floral murals and motifs to the new residence halls, Pomona College would be able to more explicitly state Sontag and Pomona Residence Halls' sustainable goals.

Figure 29



Recommended Alterations to New Residence Halls' Interiors

More Plants, Better Health

Increasing the amount of plants within Sontag and Pomona Residence Halls is a low-cost method that would do a great deal to enliven the new, impersonal, and

²³⁵ <http://www.mattersofstyleblog.com/2009/06/crazy-for-quatrefoils.html>

somewhat-stark structures. According to Kellert and backed by scientific studies described above, the mere insertion of plants into the built environment can enhance human beings' comfort, satisfaction, well-being, and cognitive performance.²³⁶ To ensure that additional plants have the desired positive effect, they should be placed within well-frequented areas of the new residence halls, yet not hinder walking paths. In other words, plants should be located in highly visible areas of the new residence halls, such as the main lounge area, study rooms, and computer rooms (Figure 30), yet not necessarily within the center of the rooms in which they are placed. Such placement would ensure that occupants and visitors of the Sontag and Pomona Residence Halls experience the daily benefits of seeing and interacting with these plants, such as reduced stress levels and more rapid healing after surgeries, without being disrupted by the plants physical location.

Figure 30



²³⁶ Kellert, Stephen. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*.

Along with placing plants in larger public spaces, it would also be beneficial to put plants within the common room areas of each suite (Figure 31), as many students walk through and spend a great deal of time working, eating, and socializing within those areas.

Figure 31



More Rocks, More Character

In addition to incorporating more plants, augmenting the amount of rocks within main areas of the new residence halls is another inexpensive means of increasing the amount of natural biophilic features within Sontag and Pomona Residence Halls. By building off the idea that Ehrlich and his design team began with their placement of rocks underneath the new residence halls' main stairways, a redesigned Pomona Hall could include more rocks within the popular main lounge area. Specifically, certain rocks could be placed within the center or within one corner of the lounge area. These rocks could be arranged into a pattern such as Pomona College's mascot, Cecil Sagehen, or the rocks

could simply be organized into a pile. If installed, students could use these rocks for sitting on and socializing around,

Rocks could also be placed on the lounge area's non-glass wall, creating a mini-rock climbing feature (Figure 32). This rock-climbing feature²³⁷ would not only allow students to take an enjoyable study break in which they interacted with pieces of the surrounding natural environment, but it would also likely act as a focal point around which students gather.

Figure 32



Along with putting rocks on the walls within the main lounge areas, placing a small amount of rocks on all of the walls throughout both Sontag and Pomona Residence Halls (Figure 33) would give the buildings a great deal of character, something which they are currently lacking. Furthermore, putting rocks throughout the new residence halls would make the buildings more engaging and fun to explore. For example, Pomona and Sontag Residence Halls could each be filled with 47 rocks and Pomona College could

²³⁷ It should be noted that while safety considerations must be taken if such a design is implemented, the reorganization or addition of rocks should not cause any excess danger to students or visitors using the main lounge area.

make finding all of the rocks within both residence halls one of the tasks on the 47 Things To Do Before Leaving Pomona College list.

Figure 33



Increased Vernacular Design Elements

According to Kellert, “building designs that mimic or metaphorically embrace landscape and geology in their relative proximity, can lend the appearance of solidity to the built environment, making structures appear integral rather than separate from their geological context.”²³⁸ Increasing the amount of rocks within Sontag and Pomona Residence Halls would augment the amount of place-based relationships that the new residence halls possess with the surrounding natural environment. With the world’s fastest growing mountain range²³⁹ so nearby, it would be easy and inexpensive for Pomona College to draw a clear connection between this geologically significant feature and the new residence halls.

²³⁸ Kellert, Stephen. *Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life*. (2008)

²³⁹ The San Gabriel Mountains are one the world’s fastest growing mountains according to *The Los Angeles Times* article “San Gabriel Mountains a daunting place to fight fire”, (2009)

Animal Life

Incorporating some sort of animal life within one of the study rooms or main lounge areas of each building could simultaneously enliven the new residence halls' interior spaces, give the buildings more character, and contextualize the buildings within the Inland Empire. By adding a terrarium (Figure 34), which could house native desert lizards, tortoises, or snakes, to either or both new residence halls, Pomona College would be able to further highlight Sontag and Pomona Residence Halls' geographic location within the Inland Empire. In other words, these animals could serve as constant reminders to occupants and visitors of the new residence halls that small desert creatures are quite common in the Pomona College area and that their presence should not be forgotten.

Figure 34



By adding an aquarium feature (Figure 35) to one or both new residence halls, Pomona College could create (using minimal funding)²⁴⁰ a relaxing atmosphere for students and visitors to spend time in. While students could gaze into the aquarium during their study breaks, visitors could enjoy watching fish swim while on a guided tour of Pomona College. As proven by studies about biophilia (mentioned above), both students and visitors would receive noticeable health benefits by interacting with this new aquarium feature.

Figure 35



With the addition of animal life to the new residence halls' interiors, Pomona College would also provide a direct way for students to interact with nature in a positive way, such as feeding the animals and keeping them healthy. Increasing student interest in the new residence halls is essential if they are to remain in good condition over the long run. Adding compelling and interesting features, such as an aquarium or terrarium, to

²⁴⁰ According to various sources, the cost of purchasing and installing a wall mounted aquarium is approximately \$1,000. <http://www.bizarreaquariums.com/products.php?id=xtreme>

Sontag and Pomona Residence Halls is a good way to ensure that this student interest occurs.

Uniqueness

There are many places on Pomona College's campus that have a unique personality. From Marston Quad to Frary Dining Hall to the Pomona College Farm to Skyspace, Pomona College is replete with memorable and attractive places. As is evident from this list, many of the College's most desirable destinations are located outdoors and incorporate one or more natural elements. This fact demonstrates how biophilia is already positively affecting students at Pomona College even if they don't know it. Because of biophilia's importance and the patterns already seen at Pomona College, it is clear why the College should add an exciting design feature, such as live animals, to the new residence halls. If done right, Sontag and Pomona Residence Halls can become sites on par with Pomona College's other memorable places, which attract, stimulate, and relax students all at once.

Recommendations' Importance

By making natural elements more present throughout Sontag and Pomona Residence Halls, Pomona College will be able to make these new residence halls into more memorable and attractive elements of the College's built environment. As of now, the Sontag and Pomona Residence Halls lack places that promote positive, shared experiences. Creating communal social experiences that inspire creativity and nurture the intellect by enlivening and engaging the senses should be the goal of every building at

Pomona College, especially the new residence halls, which are so focused on environmentalism and sustainability. By increasing the amount of restorative environmental design within the Sontag and Pomona Residence Halls' through the addition of rocks, plants, and animals, Pomona College will be able to shift the purpose of these new residence halls away from low-environmental impact design, which isolates people from nature, and towards restorative environmental design.

Recommendations for Future Pomona College Building Projects

Although it is not possible to rebuild the Sontag and Pomona Residence Halls, it is possible for Pomona College to decide how to construct its future green buildings. Due to the importance of including biophilic design elements within the built environment and the necessity for clearly environmental aesthetics, it is essential that Pomona College consider a shift in what green standards it uses to construct its sustainable buildings. Specifically, I believe Pomona College should abandon the LEED-NC standards and instead use the LBC to guide its sustainable building practices from now on. By doing this, Pomona College will better ensure that it creates truly sustainable buildings that are not only energy efficient, but are also beautiful and enjoyable to live in. Through the adoption of the LBC, Pomona College can begin to create structures that positively affect the natural environment, that promote more positive human-nature interactions, and that better relate to the place in which they are located.

To guarantee a successful transition from the LEED-NC to the LBC, Pomona College should only hire architects that use primarily organic architecture from now on. By hiring architects and designers who approach sustainable building with a focus on

organic architecture, which is rooted in a passion for life, nature, and natural forms,²⁴¹ Pomona College will be able to better ensure that the structures it commissions use restorative environmental design.

Utilizing restorative environmental design and the LBC to enliven future buildings as much as possible is an extremely important task for Pomona College. The great Italian Renaissance architect Leon Battista Alberti remarked that “a building must appear whole like an organism.”²⁴² Contemporary architects, such as Italian architect Fabrizio Carola, echo Alberti’s sentiment: “without this living ingredient, buildings are merely sterile machines for living in.”²⁴³ Given Alberti’s statement, it is not surprising that so many buildings, including the new Sontag and Pomona Residence Halls, feel so impersonal, especially within their interior. However, it is *because* so many buildings feel sterile that Pomona College must work as hard as possible to ensure that all future buildings constructed on its campus employ restorative environmental design and incorporate biophilic design elements.

CONCLUSION

While LEED-NC has galvanized the green building industry and has helped inspire the creation of numerous other green building standards across the world, it does not currently do enough. Although the USGBC’s initial strategy of making LEED-NC certification easy to achieve has paid great dividends, this tactic is no longer acceptable given the way digital architecture has pushed green design towards “a myopic focus on

²⁴¹ Pearson, David. *New Organic Architecture: The Breaking Wave*. p. 8

²⁴² *Ibid*, 32

²⁴³ *Ibid*, 82

high technology as salvation.”²⁴⁴ This fact is evidenced by LEED-NC’s nearly single-minded focus on conservation and low-environmental impact design, both of which will no longer be enough if the green building sector is to begin constructing truly sustainable structures. This is evidenced by Pomona College’s newly constructed LEED-Platinum certified Sontag and Pomona Residence Halls.

Although these new residence halls incorporate the most cutting-edge energy- and water-saving technologies as well as a great deal of innovative sustainable building strategies and systems, these buildings still isolate occupants from the surrounding natural environment. This is due primarily to Sontag and Pomona Residence Halls’ aesthetics, which are strongly tied to the aesthetics used in historically energy intensive Modernist buildings. By supporting the construction of LEED-NC certified buildings like Sontag and Pomona Residence Halls, Pomona College is helping to ensure that green buildings continue to separate people from nature and fail to adequately encourage sustainable behavior in the long run.

It is time for Pomona College to make biophilic design elements and aesthetics a part of its green building standards. Combining biophilic elements, which have been scientifically proven to be beneficial to human health, with more clearly environmental aesthetics and energy efficient design is the only way to ensure true and lasting sustainability within the built environment. If the USGBC’s unwillingness to change LEED-NC in the past says anything about the future, it appears that Pomona College and the green building movement may need to find a different leader to follow. Fortunately, there are alternative green building standards to LEED-NC, such as the Living Building

²⁴⁴ Louv, Richard. *Last Child in the Woods: Saving our Children from Nature-Deficit Disorder*. Algonquin Books of Chapel Hill. p. 137

Challenge (LBC), which have begun to mandate biophilic design elements, including those concerned with aesthetics, within their standards.

Because of the USGBC's reluctance to alter the LEED-NC standards and the fact that the LBC encourages the creation of more resource efficient, aesthetically superior buildings to those produced according to LEED-NC, I believe Pomona College should adopt the LBC as its green building standards. This will insure that from now on, Pomona College will use its plentiful resources and status as one of the nations most prestigious universities to begin to promote the construction of buildings that are as close to living, breathing organisms as possible. By trying to integrate habitat-like buildings into the natural environment rather than try to make hermetically sealed, air conditioned boxes that focus on heating and cooling space rather than people, Pomona College can help propel the green building movement and also the environmental movement out of their historically reduction-focused, conservation rhetoric and into a new, more positively-focused mindset, which seeks to encourage human beings' constructive involvement in the natural world.

In the end, we as human beings are and never will be able to eliminate our impact on the natural environment. However, the choice of whether we want to interact positively or negatively with the natural environment is ours as a species. The built environment is a main element of our lives in which this choice will be exercised. By moving towards more holistic sustainable building standards, such as those promoted by the Living Building Challenge, and incorporating more biophilic design elements within our structures, it will be possible for green builders across the world and at Pomona

College to construct buildings that are not only extremely energy efficient, but that also encourage greater positive human-nature interactions.

Appendix 1:

LEED-NC – Leadership in Energy and Environmental Design for New Construction and Major Renovations

USGBC – United States Green Building Council

LBC – Living Building Challenge

CBC – Center for the Built Environment

HVAC – Heating, Ventilation and Air Conditioning

kWh/yr – kilowatt-hours per year

Biophilia – the inherent human need for positive interaction with nature

Nature/Natural environment/Natural world – the organic, non-man-made, flora and fauna found in ecosystems

Organic – a term signifying something that is natural or that would be found in nature

CO₂ – carbon dioxide

Appendix 2: Sontag and Pomona Residence Halls Student Survey

1. What is your gender?

- Male (40%)
- Female (60%)

2. What is your year?

- '12 (97.5%)
- '13 (2.5%)
- '14 (0%)
- '15 (0%)

3. Which residence hall do you live in?

- Sontag Hall (52.5%)
- Pomona Hall (47.5)

4. How many people live in your suite?

- 3 (12.5%)
- 4 (70 %)
- 5 (0%)
- 6 (17.5%)

5. How long have you been living in your present suite?

- Less than 3 months (75%)
- 4-6 months (25%)
- 7-12 months (0%)
- More than 1 year (0%)

6. How satisfied are you with the comfort of your furnishings?

- Very Satisfied (71.8%)
- Satisfied (25.6%)
- Dissatisfied (2.6%)
- Very Dissatisfied (0%)

Comments: -Couch is a little stiff; chair is nice

-Also I need an extra desk but I'm not allowed to have one

7. How satisfied are you with the effectiveness of the building's thermostats?

- Very Satisfied (12.8%)
- Satisfied (53.8%)
- Dissatisfied (25.6%)
- Very Dissatisfied (7.7%)

Comments: -My room's temperature feels too cold now. The ac was fine.

- I don't really understand how they work, of if you can make them work as they are supposed to, so I mostly don't touch it
- Sometimes the air will turn on and sometimes it will not. Also it is hard to figure out which button does what. It seems that buttons may or may not work.
- Heater does not work in common room. Can't program outside of "sustainable" range of temperatures
- don't know how to work heater, sometimes ac stops working
- It's 69 degrees in my room, I'm freezing, and the heater won't turn on until the temp. drops to 67. so so stupid. I'm buying a portable heater tomorrow.
- No heating...really?

8. How satisfied are you with the effectiveness of the building's window blinds?

- Very Satisfied (30.8%)
- Satisfied (46.2%)
- Dissatisfied (15.4%)
- Very Dissatisfied (7.7%)

Comments: -they're a little transparent

- let too much light in!!!
- not very effective at keeping light out in the morning
- Shadows can be seen from outside. Need more privacy.
- light doesn't bother me
- They let in too much light.

9. How satisfied are you with the effectiveness of the buildings' water efficient features?

- Very Satisfied (38.5%)
- Satisfied (56.4%)
- Dissatisfied (2.6%)
- Very Dissatisfied (2.6%)

Comments: -showers are pretty low-flow and don't get very hot.

- I am not sure I know what the building's water efficiency features are.
- Other than the toilet features of flushing, not familiar with others. The laundry machines do not use cold water even when set to "cold" setting.

10. How satisfied are you with the effectiveness of the building's electrical plugs?

- Very Satisfied (35.9%)
- Satisfied (61.5%)
- Dissatisfied (2.6%)
- Very Dissatisfied (0%)

Comments: -My non-power switch plug is on the wall that has to have the bed in front of it, so that sucks, but its fine.
-really like that you can turn off the power in an entire room.
-Power switch is a great idea!

11. How satisfied are you with the amount of light in your suite?

- Very Satisfied (18.4%)
- Satisfied (44.7%)
- Dissatisfied (34.2%)
- Very Dissatisfied (2.6%)

Comments: -The natural light is good, but light fixtures provide little light during the day when natural light isn't sufficient.
-Lights make a noise when on
-ceiling light is not bright enough
-Light from the sun. Not the lighting that was installed because those lights are dim.
-My room is dark.
-Some dark corners of the common room/bedrooms
-The lights do not provide sufficient light in the room, especially the common room because there are no lights near the windows. At night we need to have extra lights on.
-satisfied during the day (can use natural light,) but wish blinds did better job of keeping light out at night
-Common rooms could use more lighting
-I had to bring in some lamps to get some light on my desk and bed at night
-My room is can be dark when I don't use a supplimentary light.
-The common room is great, but my room has extremely low light levels even during the day
-Although at times my room feels too dark

12. How satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?

- Very Satisfied (28.9%)
- Satisfied (50%)
- Dissatisfied (21.1%)
- Very Dissatisfied (0%)

Comments: -minor glare in the afternoons in the common room
-in an east-facing room, the sunlight is way too bright in the morning, even with the shades drawn
-in my room in particular-almost no natural light

13. Overall, does the acoustic quality in your suite enhance or interfere with your comfort?

- Enhances (13.2%)
- Greatly enhances (71.1%)
- Interferes (15.8%)
- Greatly Interferes (0%)

Comments: -Not in a noticeable way. But the walls are not super thick between my room and my suitemate's

- walls are nicely sound-proof
- neither enhances or interferes...
- Excellent sound-proofing
- none really

14. How satisfied are you with the shared recreational areas in the new residence hall?

- Very Satisfied (55.3%)
- Satisfied (42.1%)
- Dissatisfied (2.6%)
- Very Dissatisfied (0%)

Comments: -People don't clean up well after themselves in the kitchens so I am hesitant to use them. The tv's don't have cable service so there is no point in having them in the kitchen lounges. The bulletin boards in front of 6person suites are only accessible to those residents living in the 6person suite.

15. How does it make you feel to know that your residence hall is LEED Platinum certified?

- Excited (10.8%)
- Proud (56.8%)
- Non-Factor (29.7%)
- Disappointed (2.7%)

Comments: -I'm not disappointed in it, but I don't really take LEED all that seriously. I'm still not sure if the solar panels are working

- Hopefully more buildings will follow!
- Can't show off the stats since the monitor on the first floor which is supposed to display our use of appliances does not work.
- LEED has a lot of problems and Pomona just wants to tout a high ranking.
- LEED kinda sucks

16. How well do you think your residence hall encourages positive interactions between human beings and nature?

- Very Well (2.7%)

- Well (56.8%)
- Poorly (35.1%)
- Very Poorly (5.4%)

Comments: -The roof garden helps with this
 -Although if it's doing it's nice, a dorm should make me want to stay inside, shouldn't it?
 -Not at all
 -(little need to go outside)
 -While there is a nice area outside the new buildings I don't think it has been used enough.
 -In that it's better for the environment it does, but it's a dorm. It would encourage interacting with nature if we lived in yurts on the quad (if Pomona would give me a yurt, I'd try it).
 -People are confined to their own suites.
 -The garden is not being used or use of it is not granted/ encouraged by the draper center which is the entity that oversees it.
 -doesn't encourage one way or another
 -The design inhibits interactions with people that live in my hall. This is the first year that I don't know the people living around me (not including my suite mates).

17. Considering energy use, how efficiently is your building performing in your opinion?

- Very Energy Efficiently (5.4%)
- Energy Efficiently (81.1%)
- Energy Inefficiently (13.5%)
- Very Energy Inefficiently (0%)

Comments: -Again, the solar panel thing. My AC has been on a lot of the time, the fireplace has been going, etc. etc.
 -The automatic doors waste too much energy especially when they break and cannot close. I don't know if the refrigerators and microwaves in the kitchens are being used enough to say that they aren't wasting energy by being plugged in.
 -It depends on how we use it!
 -The lights in hallways don't seem to turn off even without motion in the hallways.
 -i have no idea
 -Hallway lights are motion sensor and remain on for extended periods of time

18. Given the new residence halls' aesthetics, how sustainable do they look?

- Very Sustainable (51.4%)
- Average (48.6%)
- Unsustainable (0%)

Comments: -More because they have signs everywhere saying "you live in a sustainable dorm," but still
-But not ugly, like recycled benches! It all 'looks green', but of course that means nothing.
-What should sustainable look like?
-what does this question mean?

19. Did you know that the new residence halls have a real-time readout of the buildings' energy and water usage as well as solar energy production?

-Yes (56.8%)
-No (43.2%)

Comments: -I walk by it the monitor all the time
-Wait maybe. If it is that tv in the first floor then yes
-The display on first floor does not work. If there is one online, it is not well advertised.
-It never works
-It doesn't work!

20. Have you ever interacted with this real-time readout?

-Yes (37.8%)
-No (62.2%)

Comments: -it doesn't work though
-I haven't been able to get the Sontag one to work, but Pomona Hall seemed to be working.
-Once, right when I moved in. Not really the most engaging thing
-It rarely seems to work for me.
-It hasn't worked all year.
-It never works
-tried to, but I don't think it was working yet
-It doesn't work!
-I tried to use the touch screen thing on the first floor at the beginning of the year but it wasn't working.

21. Did you know that the new residence halls are designed with a state of the art storm water collection and diversion system?

-Yes (29.7%)
-No (70.3%)

22. Have you ever noticed any of the storm water system's 26 pipes located on the buildings' exterior?

- Yes (27%)
- No (73%)

23. What are your feelings towards the rocks located near the main entrances and within the elevator lobbies of the new residence halls?

- Very Positive (8.1%)
- Positive (43.2%)
- Neutral (43.2%)
- Slightly Negative (5.4%)
- Very Negative (0%)

Comments: -cute. Is this an interaction with nature?

-Pose a challenge for housekeeping and serve no real purpose other than aesthetic.

24. How often do you open your windows?

- Always (13.5%)
- Often (56.8%)
- Rarely (27%)
- Never (2.7%)

Comments: -Could have been often a few weeks ago, but it's been cold/rainy

-t's noisy. Trash is collected at 6 AM outside of CMC.
-only to get the air conditioning to turn off!

25. Do you think the new residence halls' environmental focus has changed the way you act with regards to how you live within dorms (i.e. take shorter showers, turn off the lights, started using compost, etc.)?

- Definitely: I have become more environmentally conscious and have changed my behavior (0%)
- Somewhat: I have thought a little more about my effect on the environment, and have changed my behavior some (48.6%)
- Little: I rarely think more about my effect on the environment and have changed my behavior little after living here (32.4%)
- None: I don't think about my environmental impact any more than I did before I lived here and I haven't changed my behavior at all (18.9%)

Comments: -I already was pretty conscious

-I considered myself already pretty cognizant of my environmental impact before moving in.

- I've generally been environmentally conscious and have done things like turning off lights since a long time ago
- I have not changed my behavior much because all of the environmentally conscious things I do now, I did before.
- More possible things to do. Still I don't compost because it stinks up the suite and it would help to have built-in drying racks somewhere in here.
- Turning off lights.
- I use the "main" power switch now that shuts off everything in the room - that's about it.

26. All things considered, how satisfied are you with the new residence halls?

- Very Satisfied (67.6%)
- Satisfied (32.4%)
- Dissatisfied (0%)
- Very Dissatisfied (0%)

Comments: -They're nice but many aspects are very poorly designed

- The new dorms look amazing and its great to have all of this space but there are somethings in which being sustainable might not be best suited for college dorms. My concern is the floor in the suites. Whatever it is, it peels too easily and stains. Also I don't think it was a great idea to have swipe access on some doors into the hall and not others. Also, the doors look really nice but they are super heavy. I am not that small but even I have trouble opening them and it is a hassle every time I have tons of stuff to carry. Oh one more thing, whoever thought about putting swipe access into the bike area outside Sontag clearly wasn't thinking.
- But I think there are better ways to make us more sustainable! It's not about the building overall, it's the attitude of the people living in it!

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²⁴⁵ It should be noted that all photos not given a source were produced by the author of this thesis.