Chapter 1: Building Construction

1.1 Introduction

As a concept, ‘sustainable building’ integrates multiple strategies into the design, construction, and operation of buildings. Sustainable building, or ‘green building’ represents a dynamic and healthy balance between environmental, social, and economic benefits. The goal is to use fewer resources and less non-renewable energy and water. This is achieved by using recycled materials, minimizing waste, and improving indoor air quality (USGBC 2009). Green building and campus planning contribute directly towards sustainability at Chapman, as the built environment has a direct and profound impact on the natural environment.

Buildings “annually consume more than 30% of the total energy and more than 60% of the electricity used in the U.S. (USGBC, 2013). A typical North American commercial construction project generates up to 2.5 pounds of solid waste per square foot of floor space” (USGBC 2009). According to the National Wildlife Foundation, buildings typically account for 70-90% of a school’s greenhouse gas emissions. The majority of CO₂ emissions come from “campus heating/cooling plants and purchased electricity. Other sources include campus fleet vehicles, commuters, refrigerants, air travel, and purchased goods” (NWF, 2008).

Attention to the campus plan, layout, and infrastructural systems impacts resource consumption and emissions. Sustainable building practices make the campus a vital and more productive community with healthy indoor and outdoor spaces, and reduced energy use and utility costs (Cortese, 2009). As Chapman’s campus continues to expand to accommodate more students and faculty, it is important to implement ‘green building’ awareness in decision making.

The objectives of this chapter are to:
1. Discuss the current status of sustainable building practices at Chapman
2. Explain resources available to improve building designs and operations
3. Provide examples and case studies of green building designs
4. Provide recommendations to increase building efficiencies and improve campus-wide sustainability.

“Making our buildings healthy will make us happier, healthier and more productive. Saving energy and producing renewable energy will create a sustainable energy supply. Saving and recycling water will protect this essential resource. Producing and reusing materials in a sustainable manner will assure a continuing supply in the future. High-performance green buildings that enhance learning helps a university maintain a competitive edge, and the means to attract innovative faculty, staff, and students.” (The Sustainability Project, 2001)

1.1.1 Leadership in Energy and Environmental Design (LEED)

To meet green building standards, institutions around the world look to the U.S. Green Building Council and its LEED rating systems. LEED is a voluntary, market-driven certification program. It provides nationally accepted benchmark for design, construction, and operation of high-performance buildings. LEED is applicable to buildings at any stage of their life cycle, regardless of age. New constructions and the ongoing operations and maintenance of an existing building are addressed by LEED.

To achieve LEED certification, a building must satisfy prerequisites and earning a minimum number of credits in five main categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. LEED is a holistic approach in order to strengthen the culture of sustainability at an institution. LEED is comprehensive. It includes non-
building related components such as: transportation, landscaping, waste management, and other areas not directly related to construction (USGBC, 2013).

New buildings earn credits in an additional category: innovation in design or operations, while the project is in the planning stage. LEED has several rating categories that are applicable to college campuses. These are: LEED-New Constructions and Major Renovations (LEED-NC); LEED-Existing Buildings: Operations and Management (LEED-EBOM) for individual buildings; and LEED for multiple buildings and campuses. To register multiple buildings, the area of interest must collectively earn an average score. The LEED-NC and LEED-EBOM rating systems consist of 110 total points. A building must earn 40-49 points to achieve certification; 50-59 points to achieve LEED-Silver; 60-79 points to achieve LEED-Gold; and 80 or more points to achieve a LEED-Platinum rating. For the most current LEED credit information go to: www.usgbc.org/credits.

The extra costs involved with certification are why more buildings do not pursue LEED rating. LEED adds between 4 -11% to construction costs (Green building solutions, 2013). This initial investment is returned by utility cost reduction, longer life cycle of materials and building elements, more efficient work conditions, and higher re-sale potential. Costs have gone down significantly since green buildings first started appearing in the 1990s. The market place has since exploded with green products and materials. These are now competitive with conventional products (Beaver, 2009). The process of LEED registration, design and construction review by a third-party professional, and certification requires multiple steps with associated costs. Registration of a LEED projects costs $900 for USGBC members and $1,200 for non-members. The cost of standard review is determined by building’s gross square footage. Costs average $.045/sf for USGBC members and $.055/sf for non-members. USGBC members pay $180/credit; non-members pay $380/credit. Discounts are available; membership packages vary and cost from $1,500 to $20,000 (USGBC, 2013). For more detailed information of the fees associated with LEED visit: www.gbci.org/main-nav/building-certification/resources/fees/current.aspx.

**LEED-New Constructions**

LEED-NC begins with the design process for new buildings or major renovations. This certification enables institutions to produce the highest-quality buildings possible from the ground up (USGBC, 2013). Green planning and design considers the project and budget as a whole rather than a series of independent elements. The initial design process develops an integrated building in which sustainable elements harmonize. For example, exterior west-facing sunscreens and louvres protect windows and reduce heat gain while drawing in natural sunlight (Figure 1.1). Similarly, skylights bring daylight into the main corridor and reduce energy needs for artificial lighting (Figure 1.3). External stairwells are as functional as indoor stairs but reduce energy usage and mechanic air-conditioning demands. Energy modeling applied at the design stage is significantly less costly than an energy audit and system retrofit. Buildings designed to higher efficiency standards have longer life and lower maintenance costs.

![Figure 1.1. Window louvres dissipate heat transfer while allowing for natural day lighting.](image-url)
Emory University’s Whitehead Biomedical Building earned a LEED-silver rating in 2002. The 325,000 square foot facility incorporates many green features: storm water harvesting from the roof and plaza for reuse in landscape irrigation; condensate recovery for cooling towers that divert an estimated 2.5 million gallons of water from sewers. An energy recovery system with four desiccant cooling enthalpy wheels that use air exhaust to preheat and precool circulated air is the most impressive cost-reduction. Additional design and construction costs are projected to be returned in less than ten years (USGBC, 2009). For more detailed information on each credit opportunity visit: www.usgbc.org/credits/new-construction/v2009.

LEED-Existing Buildings: Operations and Maintenance

LEED-EBOM offers opportunities to improve existing buildings that are more than five years old. Older buildings are upgraded with system retrofits to boost health, comfort and resource utilization efficiencies. Green modernizations result in long-term operational cost savings. Larger windows, skylights, light shelves, and atriums add daylight and reduce electrical energy demands (Figure 1.3). Sunscreens on west and south facing facades shade excessive heat from entering windows. Many older heat-ventilation-air-condition (HVAC) system use ozone-depleting Halon or chlorofluorocarbon (CFC)-based refrigerants. Replacing these with cleaner, more efficient systems improves indoor air quality and energy performance.

UC Santa Barbara’s Girvetz Hall earned LEED-silver in 2006 was the first University of California building to do so. Originally built in 1955, the building was renovated with waterless urinals, heating valves with individual thermostats and an upgraded building control system. Custodial services implemented a green cleaning program that uses green seal chemicals, zinc floor finishes, recycled paper products and trash bags (USGBC, 2009).

LEED Equivalency

The cost associated with LEED registration and review is the main reason building planners pass on this critical component to design and operation. When LEED certification is not a goal in pre-construction, projects often abandon sustainability goals for short-sighted cost considerations. Establishing projects as LEED equivalent will bring the University the benefits of sustainable buildings while saving the cost of certification. It is important that a LEED-qualified professional works with the architect and contractor during planning and construction. Fortunately for Chapman, campus designer Ken Murai is an advanced professional (LEED-AP).

1.2 History of Building Construction at Chapman

1.2.1 Overview
Chapman’s campus showcases historic and modern architectural styles widely recognized for its aesthetic beauty. Originally purchased in 1904, Chapman’s main campus is a landmark of original neoclassical architecture in Southern California. Chapman’s campus has expanded tremendously in the last 18 years. Prior to 1995, Chapman owned a total of 1.67 million square feet of real estate that included the main campus, residence halls, and nine houses. As of March of 2013 Chapman owned 3.4 million square feet of real estate including main campus, residence halls, and houses, as well as 3.2 million square feet of property off campus (Figure 1.4). This is a laudable achievement that demonstrates financial prudence and leadership.

Chapman has a critical relationship with AC Martin Architects for recent additions such as Kennedy Hall (1998) and Leatherby Libraries (2004). The general contractor makes all decisions concerning structural, interior and exterior materials. Sadly, Chapman has yet to implement holistic sustainability policies regarding building construction. As a leading light in Southern California, the campus lags behind most state universities in this regard.

The appliances, fixtures, HVAC systems and materials used throughout the campus reflect the decades of Chapman’s history. Each decision was thought best at that time. However, times and technologies have changed. New campus construction conforms to Title 24 code requirements, the strictest in the nation. Title 24 specifies standards for planning and design, energy and water efficiency and conservation, material conservation and resource efficiency, and environmental quality. For more information regarding California Building Standards-Title 24 visit: www.documents.dgs.ca.gov/bsc/Title_24/T24TrainingGuide.pdf.

Chapman has established campus planning, growth and development goals that reflect local ordinances and regulations. Some of these include the Historic Preservation Design Standards for Old Towne Orange, the City of Orange General Plan and the California Environmental Quality Act (CEQA) guidelines and zoning ordinances. Among other functions, the Chapman University Specific Plan provides historic preservation and enhancement guidelines, identifies the University’s areas of interest for continued growth, addresses needs for student parking, and establishes a master landscape plan. For a more detailed review of Chapman University’s Specific Plan visit: http://www.chapman.edu/campus-services/campus-planning/specific-plan.aspx.

1.2.2 Past accomplishments

Chapman has made the commitment as a responsible local and global citizen:

“Chapman University has always practiced values of conservation and preservation as they relate to reusing existing buildings on campus and as it expands. Over the course of the University’s 150+ year history it has worked to restore and repurpose buildings and homes on campus in an effort to reduce raw resource consumption, make use of the embodied energy of already existing structures, and contribute to the historic feel of the Old Towne Orange Community.”

(Chapman Sustainability Website, 2013)

Chapman’s green building philosophy, as stated on its sustainability webpage, is: the greenest building is the one already built. Chapman improves its historic buildings by updating internal lighting, heating, and cooling systems. Historical buildings on campus include Smith Hall, Reeves Hall, Roosevelt Hall, Wilkinson Hall and Memorial Hall. Systems updates are not uniform campus-wide. For example, use of Energy Star-rated appliances and fixtures is on a needs-basis after systems fail. Lighting upgrades are the most common retrofit. Automated lighting systems, which employ motion sensors, are installed in parking garages and most classrooms.
Figure 1.4. Real estate map of Chapman’s growth from 1995 to 2013 (campus planning archive).
Crean Hall is an example of a remodeled historical warehouse completed in 2009. It is a converted textile mill that functions today as an academic facility with several clinical and research laboratories, classrooms, conference areas, and office spaces (Figures 1.5 and 1.6).

![Figure 1.5. Textile Mill 1930.](image1)

![Figure 1.6. Crean Hall 2009.](image2)

Cypress Street School is Chapman’s most recent remodel of a historical building Chapman has undertaken. Cypress dates back to 1931 and served as a segregated schoolhouse in Orange County. The building’s exterior was updated and made American Disabilities Act (ADA) compliant while the interior was maintained for its historical significance. The remodel has many green features such as the original wood floor, furniture, wall-mount light fixture, and skylights. Showers were added to support automobile-alternative commuters. The building is currently undergoing LEED-certification in hopes of meeting LEED-Gold standard (Figure 1.7).

![Figure 1.7. Cypress Street School before and after renovation.](image3)

“Preservation saves energy by taking advantage of the non-recoverable energy embodied in an existing building and extending the use of it”
- Advisory Council on Historic Preservation (Chapman green building webpage)

Doti Hall completed construction in 2013. It was designed to match the neoclassical exterior of Smith, Roosevelt, and Reeves Halls. Internal energy and lighting system meet “all of the efficiencies of a LEED building” according to Senior Campus Planner Jim McInerny. Chapman, however, has no plans to certify Doti Hall as a LEED building. LEED accreditation was not a goal during the construction nor in post-construction because of the costs of registration and certification. Doti is LEED equivalent and serves as an innovative and efficient model for future

![Figure 1.8. Doti Hall, completed 2013.](image4)
campus additions (Figure 1.8).

1.3 Current Status of Building Construction at Chapman

In the fiscal year of 2010-2011 Chapman consumed 12 million kWh of energy and spent $1.9 million dollars in energy costs. Electricity sub-meters were installed in academic buildings in 2012. Individual metering of each building allows Chapman to control, document and prove the value of building retrofits.

More energy-efficient lighting was installed in Reeves, Roosevelt, Wilkinson, Kennedy, and Oliphant/Bertea Halls, Hashinger Science Center, Leatherby Libraries, Beckman hallways, and the facilities Annex. The lighting retrofit consisted of replacing T12 (1.5” in diameter) fluorescent tubes, one of the most common yet inefficient fluorescent systems, with T8 (1” in diameter) fluorescent tubes. The retrofit “improved efficiency, higher intensity, and potentially longer life due to reduced degradation in light input over time” (SBA, 2012). The lighting upgrade included a reduction in standard wattage of T8 fluorescent lamps from 32-36 watts to 28 watts. The efficiency upgrade was significant because lights account for 20% to 50% of total electricity consumption in buildings (Energy Star, 2012).

Chapman has recently implemented standards for low or zero-chemical indoor sealants, paints and cleaning products. These changes result in low or no volatile organic compound (VOC) off puts and maintain healthy indoor air quality. VOCs include a variety of chemical gasses emitted from certain solids or liquids; concentrations of many VOCs are consistently up to ten times higher indoors than outdoors (U.S. EPA, 2012). Studies conducted by the EPA found that people in the U.S. spend, on average, 90% of their time indoors (Anthony, 2009). Occupants of green buildings are typically exposed to far lower levels of pollutants. For example, a North Carolina study found that students in classrooms with abundant daylight and fresh air circulation attended schools 3.2 to 3.8 days more per year than students in conventional schools (Green School Primer 2009). These facts illustrate the effects of buildings on occupant health and productivity. An institution of higher education is wise to provide the healthiest possible environment for learning.

Chapman does not have specification policies for new additions to campus. Without specifications, decisions on buildings, water fixtures, and internal energy infrastructures are made by the general contractor, typically for short-term least cost. Sustainability manager Mackenzie Crigger is currently working with campus designer and LEED professional Ken Murai to develop specifications that meet LEED-equivalency. New building construction policies will designate specific lighting, plumbing, and material finishes. As a LEED-professional, Murai has experience with sustainable design and urges project architects to create innovative, energy conscious building infrastructures.

Upcoming Campus Buildings

Chapman is in the planning and pre-construction stage for several upcoming campus buildings. Musco Center for the Arts will be built at the northwest corner of University Drive and Glassell Street, as rendered in (Figure 1.10). The cost of construction approximates $64 million dollars. The center will house a professional theatre venue for students of the performing arts and music.

The Center for Science and Technology will be the future home of the Chapman sciences. The Center will be built on Center Street adjacent to Wilkinson Field. The new building will utilize cutting-edge technology, however,
Chapman has no plans to submit the project for LEED-certification. (Figure 1.9). To learn more about upcoming building projects visit: www.chapman.edu/discover/campus/upcoming-projects/.

1.4 Concluding Assessment

Chapman has made significant strides in many of the five categories of building sustainability established by LEED. The LEED certification of Cypress Street School and LEED-equivalency of Doti Hall will advance momentum toward smart building practices on campus. Future new construction LEED-certification will be easier. Designs can be submitted for approval and modified while in the planning stage. It is more cost-efficient to initially install conservative water fixtures and efficient HVAC and electrical systems at the design and planning stages than to retrofit systems one by one.

1.4.1 Areas of progress

Chapman had made progress in the follow categories of campus building sustainability:

Sustainable site

Chapman is doing well to promote a sustainable culture by promoting alternative transportation, providing bicycle racks, gymnasium showers, and changing rooms for commuters. Other alternative-transportation options are supported with Chapman’s proximity to Orange County Transportation Authority (OCTA) bus stops, and Amtrak train station. Reducing automobile-dependent transportation directly reduced the greenhouse gas emissions produced by the University as a whole. For information about Chapman’s sustainable transportation practices go to Chapter 7.

Sustainable materials and resource conservation

USGBC green buildings mandate that at least 50% of a project’s demolition/construction be recycled (Beaver, 2009). Abacus Construction Company began recycling 60% of construction waste at Chapman; this ultimately conserves building resources and landfill space. New BigBelly trash and recycle bins added to campus in 2013 have solar powered compactors that compress waste to
minimize dumpster pickups and trips to the landfill and recycling center to reduce the net transportation emissions of the University. For detailed information on Chapman’s recycling practices go to Chapter 8.

All new buildings and major renovations projects are alert to the chemical off-gassing of interior wall paints/sealants and use only non-toxic products. Similarly, Chapman’s custodial services Aramark use a chemical-free cleaning system called ‘blue cleaning’. Improvements to interior material selections include the use of carpet tiles instead of a single piece carpet, to reduce waste when replacement is needed. For detailed information about ‘blue cleaning’ purchasing choices at Chapman go to Chapter 6.

Water

In recent years Chapman has initiated sustainable water practices in several areas of campus. Many dorms are fitted with low-flow Energy Star fixtures and washing machines. For detailed information about Chapman’s water conservation practices go to Chapter 10.

Energy

Energy efficient designs encompass elements including building envelope design, mechanical systems, HVAC, lighting, and other controls systems. Chapman began assessing individual building energy systems by installing energy sub-meters. Automated heating-cooling-air conditioning (HVAC), with adjustable thermostats, and lighting systems are installed in all new buildings and renovations further conservation and reduce wasted energy. For information on Chapman’s energy consumption and conservation measures go to Chapter 4.

1.4.2 Areas in which to improve

As Chapman is in the design and review process for at least three new academic buildings on the main campus, it will be crucial to establish construction policies to ensure meeting benchmarks of sustainability. Policies are important to maximize the efficiency and longevity of future buildings.

As recommended to earn LEED alternative transportation credits, storage lockers near and around showers and bicycle racks would further encourage alternative transportation and decrease the University’s emissions footprint.

A procurement policy is needed on campus to ensure Chapman is using the most environmentally benign products it can afford. Materials used influence indoor air quality and occupant health. Office supplies, products, and furniture choices affect the sustainability of the built environment. Materials influence the durability and replacement costs in buildings, as well as the demands made on non-renewable resources such as lumber and steel. Salvaged and reclaimed lumber is often available, as is Forest Stewardship Certified (FSC) lumber at a competitive market price. Other sustainable purchasing recommendations can be found in Chapter 6.5

To better manage water consumption on campus LEED recommends the installation of a separate water meter for landscaping. The cost of water is not a major concern in Southern California; however Chapman is accountable for overuse and wasted water. Separate metering will better inform future improvements by isolating indoor and landscaping water use. Further water conservation recommendations can be found in Chapter 10.5.

1.4.3 Existing gaps in knowledge

The multifaceted nature of building construction make it difficult, in the scope of this audit, to get counts of energy system in the buildings on campus. Final construction costs were another challenge to determine because the design-plan-review- construction-operation-renovation stages of a building are invariably involved and time-intensive.
1.5 Recommendations

Efficiency improvements look different for existing buildings and new constructions. As stated in section 1.1, it is less expensive to implement LEED in the design process of a building than to perform multiple retrofits. LEED-designed buildings use most sustainable materials available and conservative water and energy with suitable fixtures and appliances. Retrofits to existing buildings are performed to one area at a time and is not a holistic approach.

It is hard for Chapman to build sustainable now without specified construction requirements. Often, there is a disconnect in communication between Chapman and contractors. Materials can be selected for short-term economic savings and have long-term higher overall cost consequences. Communicating LEED-equivalency to contractors can be done through seminars, workshops and regular problem/resolution discussions. It is important to engage all parties early and often to make these challenges enjoyable and educational.

1.5.1 Low cost/effort

To optimize cost saving and material saving, Chapman can implement a comprehensive database of retrofits performed, suppliers and materials used, to observe and document outcomes. The database should record the type of fixtures, appliances, and HVAC systems installed in each building. A formal record of internal energy systems will prove valuable to Chapman when future retrofits are required.

1.5.2 Moderate cost/effort

New building specification policy

To establish sustainability of future buildings, Chapman can implement a comprehensive New Building Specification Policy that incorporates designs and energy system requirements to meet LEED-equivalency. Without the financial strain of certification, LEED fees can be applied to construction costs. A formal policy will ensure that materials are not selected solely on lowest cost.

Policies should include, among other implements: lumber and structural materials be of maximum available recycled content; maximum natural day lighting with large windows and skylights be worked into design; floors and carpets be installed in tiles to reduce waste upon replacement; trees be planted adjacent to buildings and roof top gardens installed when applicable for natural shading and insulation; the most conservative fixtures and appliances; most efficient HVAC system; and automatic multiple-option lighting systems be installed.

1.5.3 High cost/effort

A high cost recommendation that will produce significant improvements to building energy systems is comprehensive energy modeling on campus. Energy modeling can begin to look at areas where the most energy is used and lost. Modeling can save thousands of dollars over the lifetime of a building. California's EMCO Systems Solutions offers multiple levels of green mechanical engineering and efficiency upgrades to many institutions. Upgrades can reduce electricity utility costs by 30% (EMCO, 2013), or about $600,000 per year in Chapman's case. For more information of energy modeling services available, visit www.emcosystems.net/epc.html.

1.5.4 Future areas of research

Future areas of research include but are not limited to: testing building insulation to assess where simple weatherization techniques can reduce heat or cold air loss. Weatherization-type awareness would include checking leaking air ducts and corroding pipes, replacing old doors, applying weather strips to windows, and sealing other bypasses. Another useful test would be to measure indoor air quality and ventilation by collecting air samples of campus buildings. Tests would
identify areas of low oxygen or chemical or bacteria content and provide reason to replace faulty HVAC components.

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1.7 References


