Green Strategies of Healthcare Design: Case Studies of Medical Centers

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Abstract

Our Common Future begins by stating that "The Earth is one but the world is not." This simple statement means that we all live here and we all need to share our resources. Whatever affects the world affects us all. The problem is that most communities only think of themselves. They consume their resources in vast quantities which would leave a void for future generations. Sustainable architecture focuses on environmentally-conscious design techniques. It seeks to minimize negative environmental impact by enhancing efficiency and moderation in the use of materials, energy, and development space. It challenges the design to have a healthy process and to utilize renewable energies and site specific resources. Sustainable architecture has proven that people who live and/or work in such buildings are happier, healthier, and have higher work productivity. The same affect applies to patients in hospitals. Recognizing the connection between health care and the building designs has help health care leaders/providers, designers, and architects engage in sustainable design and construction for healthy 'green' buildings. One could even label it healthy architecture. Healthy architecture has made the role of architects and designers to very important one for future development on healing centers.

To meet patient needs healthcare facilities consume tremendous amount of energy and resources; hospitals use twice energy per square foot as office buildings. So, the necessity of having sustainable hospitals is obvious.

In conclusion, it would be impossible to have healthy people on a sick planet. In order to keep people healthy and provide proper medical treatment and to reduce the negative effect on the surrounding environment, a sustainable "healthy" architecture must be considered.

Keywords: *healthcare, sustainable, case Study, green building, hospitals*

1 Introduction

Sustainable architecture focuses on environmentally-conscious design techniques. It seeks to minimize negative environmental impact by enhancing efficiency and moderation in the use of materials, energy, and development space. It challenges the design to have a healthy process and to utilize renewable energies and site specific resources. Sustainable architecture has proven that people who live and/or work in such buildings are happier, healthier, and have higher work productivity. The same affect applies to patients in hospitals. Recognizing the connection between health care and the building designs has help health care leaders/providers, designers, and architects engage in sustainable design and construction for healthy 'green' buildings. One could even label it healthy architecture. Healthy architecture has made the role of architects and designers to very important one for future development on healing centers.

If you were asked to identify the one building type that needed the highest quality indoor air, the lowest levels of toxic off-gassing, the greatest access to daylighting and outdoor views for occupants, the most efficient energy and water usage- in other words, the greenest building- what would you think of first? Hospitals, right? Sure you would. Hospitals should be leading the way in providing patients, experience. Sick people should have the greenest buildings of all.

In many ways, hospitals are particularly well suited to be green, high-performance buildings. Hospital operators typically own their buildings and thus bear the life cycle implications of their construction choices. Normal hospital operation consumes large amounts of resources and energy, and thus presents a great opportunity for savings from efficiency measures.

Hospitals are also particularly complex and provide unique building challenges healthcare facilities are most often multiple-building campuses of varying ages, conditions, and systems, and construction frequently occurs adjacent to occupied buildings. The design and operation of healthcare buildings is highly regulated with intense economic and life-safety oversight. Moreover, Adapting green building design to the healthcare facilities market will help ensure that future healthcare buildings are healthier, more effective, cost less to operate, and are more enjoyable places in which to work and heal.

Sustainability trends are gaining tremendous momentum in the healthcare industry. In addition to green building initiatives like building for maximum energy efficiency and reducing the use of potable water, eco-friendly work tools and furniture are integral in any effort to achieve maximum "green" in a healthcare environment. What's more, eco-friendliness in the healthcare industry may cease to be an option – and instead, become a requirement – as environmental awareness and the benefits of green building spreads.

This article is going to discuss three benefit aspects of sustainability in the healthcare industry as bellow:

Environmental benefits:

- Enhance and protect ecosystems and biodiversity
- Improve air and water quality
- Reduce solid waste
- Conserve natural resources

Economic benefits:

- Reduce operating costs
- Enhance asset value and profits
- Improve employee productivity and satisfaction
- Optimize life-cycle economic performance

Health and community benefits:

- Improve air, thermal, and acoustic environments
- Enhance occupant comfort and health
- Minimize strain on local infrastructure
- Contribute to overall quality of life

In the healthcare industry, these benefits have far-reaching effects. Reducing environmental toxins, increasing natural light and improving comfort overall can shorten patient recovery time and reduce costs associated with long hospital stays.

Here are some case studies by which, these three benefits are going to be investigated. All of these cases have achieved a LEED rating. The LEED Green Building Rating System is a benchmarking and design assistance tool for building owners, designers, and construction professionals. The system recognizes and rewards choices that improve the environmental performance of buildings, while serving as a method to compare buildings of different types and locations. LEED Version 2.0 is divided into six categories that address different areas of a building's environmental performance: Site Selection, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation and Design Process. In each category, LEED contains credits that a building project can earn. In most categories, LEED also includes a few prerequisites, or mandatory features, that the project must include in order to be considered for a LEED rating (Atwies, 2002). The current Version 2.0 is applicable to new construction and renovation projects for commercial and industrial buildings in any U.S. location (Atwies, 2002).

In total, there are 69 possible credits that a building project may earn. At a minimum, a project must achieve 26 credits to earn an award from the U.S. Green Building Council. LEED awards are divided into four levels, ranging from LEED Certified starting at 26 credits, to LEED Platinum starting at 52 credits (Atwies, 2002).

2 Case Studies

2.1 Boulder Community Foothills Hospital

Boulder Community Foothills Hospital (see figure 1) is a women and children's center in Boulder, Colorado. Designed and built by a local team, sustainability and environmental sensitivity were top priorities. The first hospital in the nation to earn LEED Certification, Boulder Community Foothills Hospital's LEED Silver sets the standard for energy and environmentally responsive healthcare facility design. The project included use of environmentally-friendly materials, an extensive construction waste management plan, use of native plantings, and exceptional attention to indoor air quality. The result is a facility that maximizes patient comfort while minimizing environmental impacts and operational costs (Keeler, 2009).

The designer, OZ Architecture, was retained to design this facility to achieve many goals, but most specifically, to create a facility to nurture the health-related needs of Boulder County's women and children within a resort-like environment. To achieve this goal, medical equipment and nursing stations recede into the background as local art adorns walls and niches, and the pediatric unit provides a camp-like setting to help reduce apprehension. Twinkle-stars light the corridor ceiling at night and colorful porches and murals mark entrances to the children's cabins. A three-sided courtyard, outdoor seating, and nature walk areas foster healing of patients and visitors alike. Acknowledging evidence that patients heal more quickly with the support of their families, all patient rooms accommodate overnight visitors.

Figure 1: Boulder Community Foothills Hospital.

Parents may remain overnight during their child's hospital stay and a state-of-the-art Special Care Nursery provides both a private room for newborns requiring prolonged medical attention and an adjoining room for the infant's parents. In addition to labor and delivery, neo-natal intensive care and pediatrics, the facility also houses an emergency room, a surgery department and a full imaging department. Native Colorado materials were used for the structure as well as the building facade, and wherever practical, products and manufacturers were selected within a 500-mile radius. Many of the products incorporated recycled material, and 64% of jobsite construction waste was recycled. The hospital achieved a Silver Rating under the LEED 2.0 Program, becoming the first hospital in the country to receive LEED certification from the U.S. Green Building Council.

2.1.1 Environmental and economic benefits

2.1.1.1 Energy

- Efficient daylighting and electric lighting; daylight and occupancy sensors
- In this hospital, daylighting is used primarily to light the central, two stories, and entry space. Lighting does not affect adjacent neighborhoods. Up-lighting, bleeding and light pollution is non-existent. Day-lighting is maximized in occupied space. Sensors in rooms shut off lights when no one is present. Also, BCFH complements the benefits of daylighting with dramatic views of the Flatirons and natural ventilation. When a patient opens a window for fresh air, a sensor notifies the HVAC system to shut off room's air conditioning (Jones, 2008).
- Energy Star reflective roof, with high R-value (R-30)
- A reflective roof was installed and insulation in the roof and exterior walls was increased to minimize heat gain in the building, which also minimizes energy usage. To have minimum annual heating and cooling cost, it is recommended to use a minimum R-30 roof insulation.
- Energy-efficient glazing
- There is a low E (short for emittance) glass that contains an invisible metal coating that sandwich between the layers of glazing, which causes the glass to be reflective. They keep the building warmer in the winter and cooler in the summer.
- Exterior sun shading on west and south
- In addition, to capture as much natural light as possible, one wing of the hospital constructed at a precise angle to maximize the Colorado sunshine. Some of the windows are quite large with dimensions sometimes greater than 46x66-inches.
- Highly efficient Central Utility Plant (CUP)
- The Hospital made a large capital investment in a central utility plant to provide a 12 year payback through energy savings. Such an investment as well as adhering to the LEED requirements throughout the design and construction process, clearly demonstrate the hospital's commitment to a long-term, sustainable approach to building design and operation, and to first-class patient care. Multiple sustainable design awards and national and international recognition have followed.
- Additional commissioning – extensive third party
- 30% savings over LEED baseline

2.1.2 Environmental benefits

2.1.2.1 Site/Water

1. Maintain wildlife corridor and sensitive to floodplain

To remove the building site from the 500-year floodplain, fill excavated for a downtown underground parking garage was trucked to the site at no cost to BCH. And as part of its development agreement with the city, BCH agreed to make improvements to a flood wall that protects a neighborhood located south of BCFH (Yudelson, 2006).

- Erosion control
- Restoring wetlands for filtering storm water (with oil interceptors first)
- Permeable pavers for fire lane

To reduce the amount of pavement further, the fire lane on the site has grass pavers. These pavers allows you to park, drive, walk, ride, or lounge on a beautiful grass surface. It performs, but with the aesthetic of a lawn-all while enhancing the environment.

- Near transit, added bus shelter
- Bicycle facilities, showers
- Reducing parking 25% beyond zoning via variance, preferred parking for carpools

As a long time proponent of alternative transportation modes, BCFH received four LEED points for the site's proximity to high-frequency transit service and the provision of employee transit passes, providing bicycle storage and easy access to showers and changing rooms for employees, as well as offering dedicated parking spaces for carpools. Because of its policy of providing employees with free transit passes, the hospital was able to vary the city's building code requirements and build 25 percent fewer parking spaces than required. The hospital has reserved on-site space to build more parking in the future if necessary.

2. Minimized light pollution

In addition to energy saving, BCFH also focused on providing a sustainable environment around the hospital. Outdoor lighting was carefully designed to reduce light pollution in the night sky. Light pollution caused by the scattering of artificial light in the atmosphere, much of which is caused by poorly-designed luminaries.

3. Waterless urinals and efficient sensor fixtures

More explanation about Waterless urinal, it saves on average 20,000 to 45,000 gallons of water a year. Twenty-two Waterless urinals can save up to 1,000,000 gallons of water per year. It can be estimated that there are approximately 8 million urinals installed in the US alone with approximately 100 million people using these fixtures. Assuming an average 2 gallon flush, the potable water use of urinals alone, in this country per year, is approximately 160 billion gallons.160 billion gallons of water is equivalent to the water usage of 490,000 homes or 1.9 million people per year. This vast amount of outflow to the sewer and septic systems can be eliminated and will not run into our natural waterways and oceans. On your local level this could mean: A typical office building rest room with three urinals and 120 men equals a yearly water use of 237,600 gallons of potable water flushed down the drain. This assumes three uses per person per day and only 220 working days (Waterless, 2009).

4. Low water use and xeriscape plantings

The hospital architects focused on local and regional low-emitting materials, reduction of water use through xeriscaping (landscaping that does not require supplemental irrigation), low-flow fixtures, and energy reduction. BCFH incorporates numerous strategies into its landscaping plan. These strategies, which heavily rely on the use of native and drought-tolerant vegetation, reduce the hospital's irrigation water requirements by more than 50 percent. Xeriscaping is a good example of how the green approach, while initially more costly, becomes the smartest environmental and economical approach over time (Yudelson, 2006).

2.1.2.2 Waste/Construction practices

The project also received a LEED point for diverting construction waste, achieving a 64 percent recycling rate. A strong focus was placed on integrating recycled- content building materials and locally harvested and manufactured materials into the project. 75 percent of the materials used in construction contain recycled content, and as many locally manufactured and harvested materials were used as possible, most visibly in the building's façade where the brick and sandstone came from local suppliers.

- Site fill obtained for free from a nearby site that was excavating
- LEED IAQ protocol is standard practice
- Construction staging management and flush out period
- New filters after flush out

Newly constructed, renovated, and remodeled buildings can emit air pollutants from various components used in the construction process such as adhesives, paint, carpet, furnishings, etc. In an effort to remove indoor air pollutants, some buildings undergo a pre-occupancy flush-out where a large amount of tempered outdoor air is forced through the building via the ventilation system. A flush-out typically lasts between 3 to 30 days depending on the building material and furnishings, allowing the majority of pollutants to be removed from the building prior to occupancy.

2.1.3 Health and community benefits

2.1.3.1 Materials/IEQ:

Exemplary indoor air quality was achieved through by specifying low-*VOC* materials, installing all materials in proper sequence, and performing a two-week building flush out prior to occupancy (Guenther & Vittori, 2007).

Volatile Organic Compounds (VOCs):

Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.

2.1.3.2 Operations

comprehensive recycling and Environmentally Preferable Purchasing (EPP) programs in place and designed for in new (Guenther & Vittori, 2007)

2.1.3.3 Innovative

Credits for encouragement of alternative transportation, and extremely high amounts of local and recycled content materials. (updated September 2005)

2.2 Dell Children's Medical Center

Architect: Karlsberger, Columbus, Ohio

Dell Children's Medical Center of Central Texas is the first hospital in the world to receive the LEED (Leadership in Energy & Environmental Design) Platinum designation, given by the U.S. Green Building Council.

Dell Children's, which occupies nearly one-half million square feet on 32 acres, opened in June 2007. Its environmentally-sensitive design not only conserves water and electricity, but positively impacts the hospital's clinical environment by improving air quality, making natural sunlight more readily available, and reducing a wide range of pollutants.

Inside the facility, sunlight reaches 80 percent of the available space. Outside, sustainable and indigenous building materials were used throughout the façade. A 4.3 megawatt natural gas-fired power plant produces 100 percent of the hospital's electricity, heating and cooling.

The planning approach places the inpatient units opposite parking areas, and develops a therapeutic garden between and around the twenty-four-bed units.

Patient rooms provide views of the gardens and more distant vistas of the downtown Austin skyline. In addition, the two-story diagnostic and treatment block is pierced with four plan-enclosed courtyards. Each of these has a distinctive garden response based on native plants from the seven eco-regions (forty-two counties) served by the children's hospital. The diverse palette results in unique, bioregionally focused experiences connecting children to the familiar while educating them about broader regional differences (Guenther& Vittori, 2007).

Within the parking areas, trees are positioned to reduce heat island impacts. The perimeter site landscaping is based on native, drought-tolerant plants. Where required, drip landscape irrigation is provided by the municipal reclaimed water system.

2.2.1 Economic benefits

2.2.1.1 Sustainable Site

- 47,000 tons of Mueller airport runway material was reused on the site
- About 40% fly ash instead of Portland cement in the concrete mix yields a drop in carbon dioxide emissions equivalent to taking 450 cars off the road
- Courtyards provide light to interior spaces; courtyard air intakes provide cooler air than rooftop intakes for air conditioning
- 92% of construction waste was recycled on site

Reuse – Instead of removing and dumping asphalt from the old airport runways, general contractor White Construction opted to grind up 35,000 tons of asphalt and reuse it on the muddy job site as stabilized base for parking areas. Reusing the asphalt generated LEED points for recycled materials (Durio, 2006).

Less Cement – One of the team's goals was to reduce cement use, which creates carbon dioxide and contributes to the greenhouse effect. Instead, they substituted fly ash [a coal combustion product] for a portion of the cement, pouring 41,000 cubic yards of the fly-ash concrete on the foundation and walls (Durio, 2006).

Fly ash- Fly ash (also known as a coal combustion product or CCP) is the mineral residue resulting from the combustion of powdered coal in electric generating plants. Fly ash consists mostly of silicon dioxide, aluminum oxide and iron oxide. It is pozzolanic in nature, meaning it reacts with calcium hydroxide and alkali to form cementations compounds (Durio, 2006).

2.2.1.2 Energy Efficiency and Energy Conservation

- Efficiency measures save enough power to fuel about 1,800 homes
- An on-site natural gas turbine supplies all electricity, 75% more efficient than coal-fired plants: links to the municipal grid and an emergency generator provides backup
- Converted steam energy from a heating/cooling plant supplies all chilled water needs
- Under-floor air distribution in non-clinical, non-patient areas requires less fan power than above-ceiling ducts

- Parking lot trees and reflective surface pavement and roof materials reduce the heat-island effect

Energy Onsite – Austin Energy system is completing an onsite 4.6 megawatt heating/cooling plant that will produce steam and chilled water efficiently, as well as generate seven to eight LEED energy points. "It would take a catastrophe to lose power at this facility," said Bell (Durio, 2006).

2.2.2 Environmental benefits

2.2.2.1 Water Efficiency and Water Conservation

- Reclaimed water is used for irrigation, xeriscaped landscaping uses native plants which require less water
- Low flow plumbing fixtures

Water and Energy Conservation –It is difficult for a hospital to achieve much water conservation because of cleanliness requirements. But dual flush toilet valves and motion sensors that automatically control water flow will reduce water usage by 30 percent (Durio, 2006).

2.2.3 Health and community benefits

2.2.3.1 Indoor Environmental Quality and Lighting

- Most interior spaces are within 32 feet of a window
- Motion and natural light sensors shut off unneeded lights

Natural Light – A hub and spoke design incorporates seven interior courtyards that bring natural light throughout the building. The courtyards represent the ecosystems found in the hospital's 40-county service area, and place natural light sources within 64 feet throughout the facility. "In addition, the courtyards are a great way-finding tool for young patients who can't read signs yet, and provide a place for families to relax and preoccupy themselves," said architect Zilles (Durio, 2006).

The hospital features a combination of natural and artificial light (see figure 2right) (Kuspan & Mann, 2007).

2.2.3.2 Conservation of Materials and Resources

- Use of local and regional materials saves fuel for shipping

Mesquite wood and red sandstone are among the natural materials used in the building's design and are significant wayfinding elements (see figure 2Left) (Kuspan, J. F., & Mann, G.J.).

- Special paints and flooring emit low levels of volatile organic compounds (VOCs).

Healthy Interior – The hospital gained LEED points for healthy interior selections, such as paints and adhesives with low or no volatile organic content. For example, most of the flooring is natural linoleum applied with green label adhesives. In carpeted areas, flooring contractor Intertech Flooring chose carpet with recycled content and backing made of recycled soda bottles (Durio, 2006).

Job Site Recycling – Approximately 70 percent of construction waste is being recycled through the project's aggressive recycling program, which designates different types of dumpsters for drywall, stone, wood/paper, general trash and so on. "This is something that's gaining momentum, but is still relatively new in the building trades," said White Construction Senior Project Manager Alan Harbert. "There are some additional costs that you don't traditionally have, but there also are some rebates for recycling" (Durio, 2006).

Natural linoleum flooring that is biodegradable, formaldehyde-free and nontoxic is among the 'green' materials used.

Figure 2: Dell Children's Medical Center.

2.3 Fletcher Allen Health Care

The Fletcher Allen Health Care, located in the heart of Vermont, includes new buildings and renovations of existing buildings designed to integrate healthcare, education and research into one cohesive campus environment. Almost the first thing we noticed was that the project team deserved special credit for placing the parking for this facility underground, thus preserving the beautiful landscape and eliminating the dreaded parking-lot deserts common to too many facilities. The connections of the medical school to the hospital are very nicely done in this durable, solid, 100-year building. The planning is well done and the architectural design is strong and convincing (see figure 3).

In 2009, Fletcher Allen has reduce consumption by another 2.5 million kilowatt hours and saved an estimated $250,000 in utility costs in the first seven months of the year.

The efforts also carry over into nutrition services. In 2006, Fletcher Allen adopted the Healthy Food in Health Care Pledge, which contends that the methods used to produce and distribute foods often are not aligned with dietary guidelines and rely too heavily on practices that adversely affect public health and the environment. Signing the pledge "solidified" efforts to buy goods from local farms to cut down on transportation and reduce pollution, says Diane Imrie, director of nutrition services. Managers and supervisors also identified ways to reduce waste, so everything a person "eats on, in, or with is either recyclable or compostable," Imrie says (Leiser, 2009).

The hospital stopped using foam and plastic cups and plates, instead choosing products made from 100% reclaimed fibers that fully degrade into water, carbon dioxide, and organic material when composted. They replaced disposable catering trays with reusable trays, a move that saves about $1,000 a year (Leiser, 2009).

Laer in May, the medical center unveiled its new Harvest Café. The facility is designed to be "the most sustainable cafe in healthcare" across the country, Imrie says. The menu at the cafe—referred to by some in-house as "the starship"—incorporates such locally grown organic fare as soy milk and squash. It serves turkey and chicken raised without nontherapeutic antibiotics or arsenical compounds, and it also offers fair-trade coffee, which is produced without pesticides (Leiser, 2009).

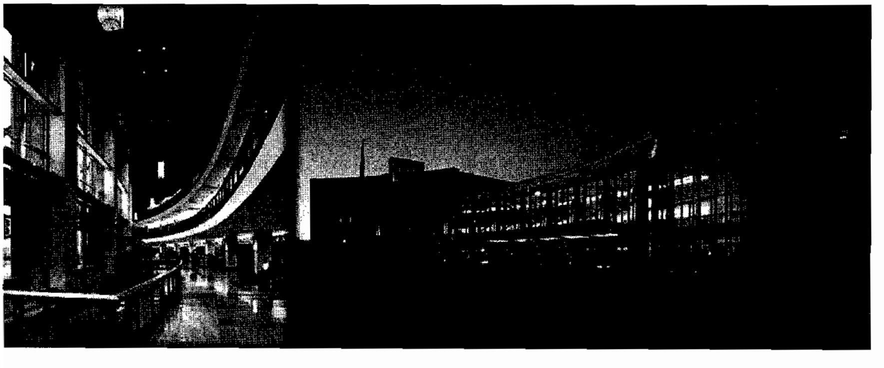

Figure 3: Fletcher Allen Health Care

Vermont's Fletcher Allen Health Care purchases local hormone-free meat rose without the use of antibiotics; serves local produce, fair-trade coffee and milk produced without the use of rBGH (a hormone given to increase milk production and banned in most industrialized countries except the United States). The facility composts waste and educates the community about the links between local food, nutrition, and health (Harvie, 2008).

The Project received several awards such as Boston Society of Architects, Healthcare Facilities Design Award 2006, Environmental Excellence 2010 award, among others.

2.3.1 Health and community benefits

Materials/IEQ: (Guenther & Vittori, 2007)

- Reducing PVC use
- TPO (Thermoplastic polyolefin) E star roof

ENERGY STAR qualified roof products reduce the amount of air conditioning needed in buildings, and can reduce energy bills by up to 50 percent.

- Low or no formaldehyde and low or no VOC indoor finish materials

2.3.2 Economic benefits

Energy: (Guenther & Vittori, 2007)

- High performance glazings
- Replaced an aging air handler with a more efficient water-chilled model. The new unit cost about $57,000, but it is expected to conserve 4.6 million gallons of water each year. That will translate to $36,000 in annual savings, helping recoup the initial investment within two years.
- Composted more than 286 tons of waste and set a goal to recycle an additional 40 tons this year, which would save several thousand dollars in landfill hauling and tipping fees.

Reduced its energy consumption on its main campus by 8% by tackling projects both large, such as replacing the air handler, and small, such as adding insulation on steam valves and shifting to more efficient lighting.

2.3.3 Environmental benefits

Site/Water: (Guenther & Vittori, 2007)

Storm water management retain age basin & filtration

Waste/Construction practices: (Guenther & Vittori, 2007)

Seeking a high diversion of construction and demolition diversion

Operations: (Guenther & Vittori, 2007)

Compost out & organic food in

3 Comparison

Green hospitals are creating sustainability councils or "green teams" that involve many specialties rather than hiring one sustainability coordinator. The groups usually meet monthly or quarterly. Conversations range from how to reduce waste and promote alternative transportation, to how to utilize alternative energy sources, conserve water, and purchase environmentally friendly products. Such panels are the prominent parameter which is similar among three cases that provide an excellent opportunity to take an active role in the greening of their facilities.
Making general comparison between above cases, results listed points:

- Among these three hospitals, BCFH and Dell made innovative strategies to get a "sustainable site". BCFH is more sensitive on the aspect of natural features and also site's facilities and transportation, while Dell considered economic aspects more.
- By various techniques BCFH saved energy 30% above LEED. But in comparison with on-site natural gas turbine, supplies all electricity, Dell is more successful in "energy saving"
- Among these case studies, BCFH is the only one in which light pollution has been considered. Outdoor lighting was carefully designed to reduce light pollution in the night sky.
- In order to reduce water usage, Dell Medical Centre, used dual flush toilet valves and motion sensors. While BCFH considered waterless urinals, and Fletcher Allen replaced aging air handler with a more efficient water-chilled. In comparison of these three ways, BCFH and Fletcher Allen's methods are more efficient.
- Fletcher Allen created a distinctive hospital by integrating medical, educational and research spaces. This integration cause operation of the latest research results into medical performances.
- The unique strategy in Fletcher Allen is green nutrition services, by usage of local farm and green materials for dishes. This consideration bolds Fletcher Allen healthcare among the others.

4 Conclusion

Despite the challenges, today's health care institutions are finding new ways to incorporate green design strategies into new construction to speed healing, not only of patients, but also of the planet. The first challenge involves finding meaningful ways to identify appropriate strategies and measure their effectiveness.

More than an optimization of any single component, sustainable design and construction represents the integration of materials and methods that, together, create the physical manifestation of a building. The entire life cycle of building materials and products, as well as the building as a whole relative to its physical, environmental and human contexts on the local, regional and global scales, must be evaluated for environmental and health considerations.

According to case studies investigation, we could conclude that a project checklist for a sustainable design will include:

4.1 Economic considerations

- Labour skills and training
- Regional economic benefits
- Savings through energy reductions
- Life cycle cost planning- capital cost vs. maintenance burden.

4.2 Environmental consideration

- Use of and specification of sustainable responsible materials
- Energy efficiency in design
- Water use management- in construction and design
- Carbon reduction- efficiency in plant
- Waste management- in reuse and minimizing over-ordering. Recycling throughout
- Managing noise, vibration, transport disruption to local environs
- Avoiding pollution locally during construction- water airborne

4.3 Community consideration

- Consultation and presentation
- Health and safety on and around site
- Managing disruption to ongoing hospital facilities
- Holistic and best practice design- a healthy environment and faster healing

Supporting green initiatives goes beyond building design and materials. A sustainable facility that respects its fulltime and temporary occupants as well as the Earth, has the potential for better staff recruitment and retention, greater control over the spread of infection, better patient outcomes, and improved stature within the community. Small successes like an energy audit or move to a greener cleaning protocol may break down obstacles to greater innovations.

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