Case Study: Tampa General Hospital Sustainable Addition

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Abstract

This report presents two estimation techniques for different construction tasks: concrete and finishes. For the concrete estimate, the report details the takeoffs for the 4" slab, thickened slab, continuous footer, and stem wall. For the finishes estimate, the report assumes specifications for material and crew composition for the acoustical tile and drywall ceiling systems. This report provides a comprehensive overview of the estimation techniques used for these construction tasks, including material costs, crew composition, and production rates. The report concludes that the proposal will include furnishing material and labor for the construction tasks and will qualify the fact that the drawings did not provide a material specification.

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The Building Rating System (LEED)

Tampa General Hospital constructed a LEED BD+C: New Construction Gold-certified neonatal expansion in 2012. The project team consisted of the architectural firm Harvard Jolly Architecture, general contractor and construction manager Skanska, the structural engineer firm Walter P Moore, and MEP designer Smith Seckman Reid, Inc. (Durkin, 2012). The project consisted of the addition of a 20,000-square-foot single-story building, renovation of a 30,000-square-foot existing area, and additional 4,000-square-foot penthouse added atop the existing building (Durkin, 2012).

The existing building is located in Davis Island, Florida, a wealthy suburb of Tampa. The purpose of the project is to double the existing neonatal intensive care unit (NICU) capacity from 42 to 82 beds (Durkin, 2012). The additional 4,000-square-foot penthouse will house new HEPA-filtered mechanical equipment dedicated to the NICU (Durkin, 2012). The 50,000-square-foot 82-bed building will become the largest private NICU in the area.

According to *USGBC Case Study* (2012), the project was completed over two phases consisting of the first phase, new construction, completing in December, 2010, and the second phase, renovation, completing in May, 2011. During that period, the project earned 41 credits and achieved LEED Gold certification by implementing integrated strategies to reduce energy usage while increasing patient comfort, reusing 96 percent of the original building, constructing with 21 percent high-recycled content materials, and using 60 percent of wood products certified by the Forest Stewardship Council, among other techniques.

Sequencing for items that earned the project LEED points began with the reuse of the existing building instead of tearing it down and building a new structure, as well as the location of the site which is walkable and accessible by public transportation. The parts of the project that were new construction mitigated detrimental environmental effects by diverting 51 percent of construction waste away from landfills (*USGBC Case Study*, 2012). Of the building materials used, 21 percent used high-recycled content (HRC), although it is not specified which materials those were. The materials could have incorporated recyclables such as fly ash in the mortar, recycled content in the concrete aggregate, or portions of the structural steel containing recycled content. Finishes, such as the metal grid used in the acoustical ceiling system, are also available as LEED-certified HRC products.

The MEP design was a large contributor to LEED points, as both interior and exterior lighting were optimized for reduced energy consumption. The building's thermal control systems were designed to meet higher human comfort standards by controlling temperatures and incorporating outdoor air while giving occupants more control over their individual comfort settings. Additionally, water usage was reduced by 40 percent by using ultra low-flow showers and dual-flush toilets (*USGBC Case Study*, 2012).

Finally, at least 60 percent of the wood used for interior finishes was certified by the Forest Stewardship Council and indoor air quality was managed by installing products with low volatile organic compound (VOC) levels. These materials were also formaldehyde free. According to *USGBC Case Study* (2012), the hospital campus already had a long-standing commitment to recycling. That commitment was extended to the NICU by providing recycling stations throughout the building for paper, plastic, aluminum, glass, and cardboard.

High-Performance (Green Building) Features Used in the Building

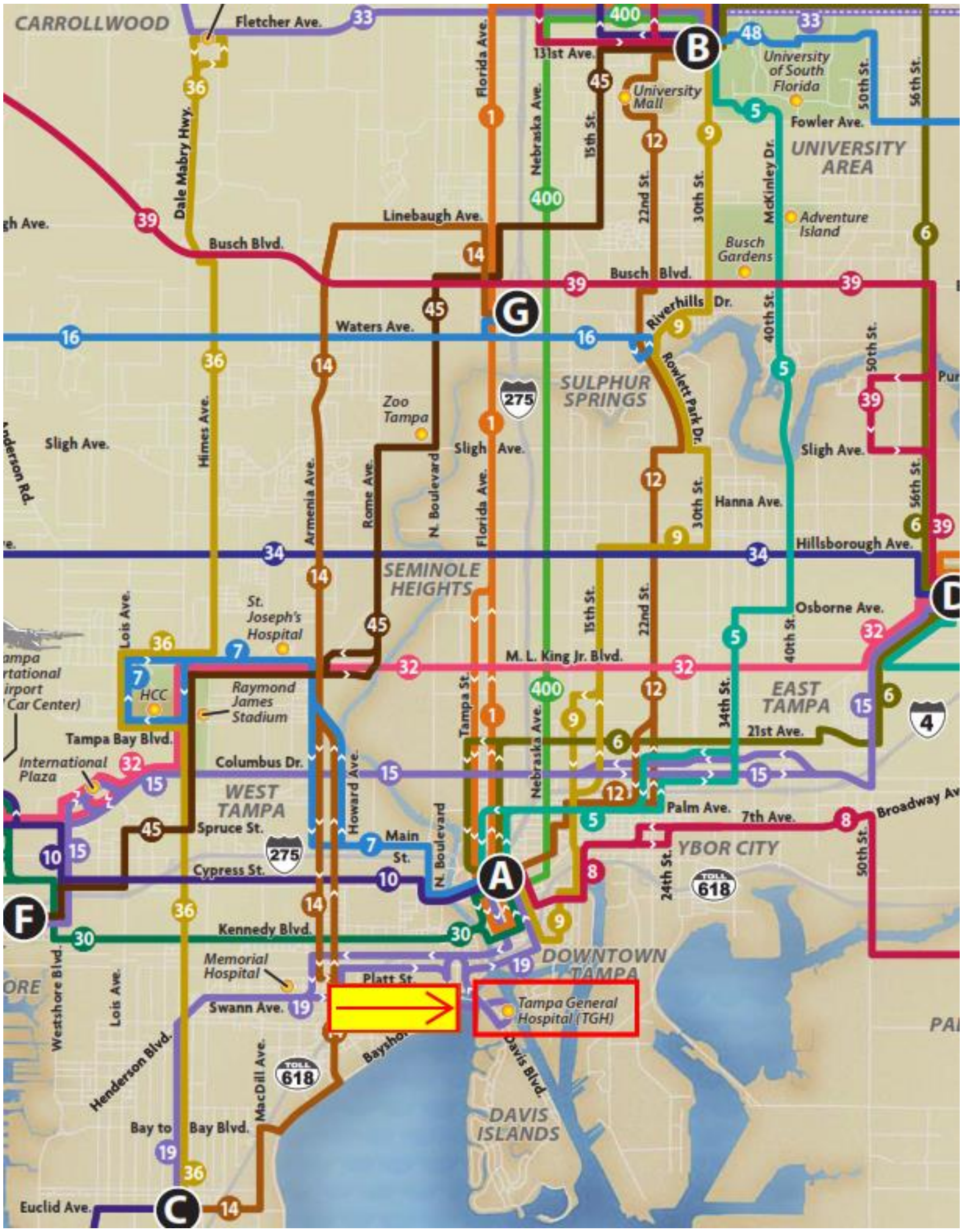
Tampa General Hospital's (TGH) 2012 neonatal intensive care unit (NICU), built by Skanska in 2012, is a LEED BD+C:NC Gold-certified building in Tampa, Florida. The high-performance features used in the design and construction of this building contribute to positive economic, societal, and environmental benefits of the end project when compared with buildings constructed with traditional methods. Many high-performance features earn a single credit, such as the roofing system, and at least 60 credits are required for LEED Gold certification. In this paper, the business cases of three specific features are identified and described in terms of the design considerations and practices for sustainable buildings as outlined in *The Local Government Sustainable Buildings Guidebook.* These high-performance features include the building's siting, integrated strategies to reduce its energy consumption, and the use of heat-reflective roofing materials.

Siting

According to *Local Government* (1993, as cited in Kibert, 2016), site planning should "optimize employee commuting and customer transportation options and minimize the use of single-occupancy vehicles" (p. 98). This is a difficult task in the Tampa Bay region, which ranks 29th out of the 30 largest metro areas for four of the six ways the federal government measures public transportation coverage and usage and 30th in the other two (Johnston & Zhang, 2017). Still, TGH managed to reuse and improve an existing location, including adding almost 20,000 square feet of new construction, and provide an area accessible to almost all of Tampa Bay through public transportation, as shown in Figure 1.

Figure 1

Map of Public Transportation Routes Servicing TGH



Note. HART system map [Illustration], 2021, by Hillsborough Area Regional Transit Authority (http://www.gohart.org/Style%20Library/goHART/pdfs/maps/HART-SYSTEM-MAP-120521.pdf).

This location fulfills all three business cases of the triple bottom line. It avoids negative impacts on the environment by reusing an existing site instead of constructing a new building. The site benefits society because the public transportation options make it accessible to both patients and employees. And economically, there is less of a need for parking spaces in an already cramped island because of the public transportation options, and there is a reduced cost for site preparation, since the building is existing.

Energy Efficiency

Design considerations for sustainable building outlined in *Local Government* (1993, as cited in Kibert, 2016) state that "the building shell should be designed for energy efficiency" (p. 98). While it does not specifically state how, *USGBC Case Study* (2012) states that the design of TGH achieved a 29 percent energy reduction for interior lighting, 78 percent reduction for exterior lighting, and 13 percent annual reduction in energy consumption for cooling. The building also was designed with thermal controls that allow for more individual controls over lighting and thermal comfort.

According to Nelson (2016), incorporating compact florescent lamps, soft-start electronic ballasts, and designing for natural daylighting can decrease energy consumption of lighting by 30 to 60 percent while increasing lighting quality. The author also states that dynamic glass and reflective glass can contribute to a building's energy efficiency by blocking solar radiation and decreasing cooling costs. These are some of the high-performance features that may have been implemented in the design of TGH to increase energy efficiency.

The Office of Energy Efficiency and Renewable Energy (2003, as cited in Kibert, 2016) explains the business case for energy efficient buildings in regard to the triple bottom line. The author states that the economic benefit of energy efficiency includes reduced operating expenses and, at a more global level, a reduction on the demand for new energy infrastructure. The societal benefit comes from increased patient comfort resulting from more individual control over temperature as well as the cooling system's incorporation of humidity control and use of outdoor air. Reduced energy use benefits the environment through a reduction in fossil fuels burned to create energy, leading to the emission of fewer greenhouse gases (Office of Energy Efficiency and Renewable Energy, 2003, as cited in Kibert, 2016).

Materials and Resources

Local Government (1993, as cited in Kibert, 2016) states that high-performance, sustainable buildings should incorporate materials that lessen local and global impact. One negative environmental impact of constructing large buildings in urban settings is the resulting heat island effect as vegetation, which provides shading and cooling to the surface, is replaced with asphalt, concrete, and buildings, which absorb solar radiation rather than reflect it (Center for Science Education, 2022). This raises the surface temperature locally, causing increased demand for air conditioning and electricity (Santamouris, 2020). Increased energy consumption creates additional greenhouse gases, and the heat island effect can also put sensitive populations, like older adults, young children, and low-income populations, at greater risk due to exacerbating naturally occurring heat waves (Gamble et al., 2013).

To take advantage of the convenience of being located in a densely-populated urban area while mitigating the heat island effect, TGH used heat-reflective roofing materials (*USGBC Case Study*, 2012). While the case study does not specify the type of LEED-certified reflective material that was used on the roof, the U.S. Department of Energy (n.d., as cited in Kloepple, 2019) states that LEED v4 cool roofing materials include highly reflective paint, metal sheet covering, or highly reflective tiles or shingles. Most likely, the hospital used a highly reflective

PVC fabric-reinforced membrane, similar to one used at Children's Medical Center of Daytona (Florida) in 2009.

Using materials to mitigate heat islands has a positive impact on the environment, society, and economy of the project. Lower adjacent surface temperatures reduce the need for electricity to provide cooling, which is of particular concern in Florida during the spring, summer, and fall, when many days naturally reach temperatures in the 90s. The benefit to society is a more comfortable, safer place to live and work without increasing already present health risks during naturally occurring heat waves. And the building will incur lower operating expenses for cooling as well, since it is reflecting rather than absorbing solar radiation.

Low-energy building strategies

Tampa General Hospital's (TGH) $35-million neonatal intensive care unit in Tampa, Florida is a high-performance building built to LEED BD+C: New Construction Gold certification standards. This project included low-energy building strategies such as the use of site lighting to improve interior lighting and reduce the need for artificial lighting and integrated strategies to reduce energy consumption by the cooling system. It may have also incorporated the use of building energy simulation software to model daylighting and energy usage impacts on various designs as well as the installation of high-performance insulation materials.

According to Kibert (2016), one of the top ten steps involved in designing low-carbon-footprint energy systems is to "maximize daylighting and integrate with a high-efficiency lighting system" (p. 274). TGH received LEED credits for reducing energy usage related to interior lighting through "careful control of site lighting" (*USGBC Case Study: Tampa General Hospital*, 2012, para. 5). While the specifics are unclear, this could have meant utilizing high windows to take advantage of natural indirect light or the use of smart control systems. Smart lighting control systems can incorporate lighting strategies such as automatically controlling artificial lighting based on ambient lighting conditions, motion-detection sensors to turn off lights in unoccupied rooms, and constant illuminance control strategies by using sensors to ensure minimum lighting energy is used while maintaining constant lighting levels (Baharudin et al., 2021). Designs and technologies like these resulted in the building's energy usage for interior lighting being reduced by 29 percent (*USGBC Case Study*, 2012).

According to Cummings et al. (1991), cooling systems account for over 30 percent of a building's energy use in Central Florida. Efficient HVAC systems can reduce that number, and hyper-efficient HVAC systems are part of the design strategy for high-performance buildings (Kibert, 2016). At TGH, energy consumption for the cooling system was reduced by 13 percent annually, which led to a 30 percent cost savings (*USGBC Case Study*, 2012). Methods of incorporating efficient HVAC systems in building design include the use of high-efficient Energy Star approved products, the use of energy recover systems for makeup air to reduce excessive air changes, and the use of energy recovery systems that pre-cool incoming ventilation air (WBDG Sustainable Committee, 2021).

While the case study does not specifically mention the use of building energy simulation software, its use would certainly be within the design budget of a $35 million building. During the design process, this type of software can model a building's energy usage throughout the year, incorporating various design ideas to gauge their impact (Kibert, 2016). Since the building is located in a southern climate exposed to hot, humid weather for the majority of the year, balancing site shading, natural daylighting, and energy consumption for building cooling systems would have been an important part of the design process to achieve low energy usage. Simulation software would have helped during the design process by giving the architects the ability to quantify design changes in regard to energy consumption impacts throughout each Florida season.

High-performance insulation materials can also help to reduce cooling costs by efficiently blocking heat from entering the building. Kipert (2016) states that high-performance building design should "maximize the thermal performance of the building envelope" (p. 274). Products like Owens Corning Insulation's Foamular XPS product line are LEED-certified, meaning that they contribute to at least a 10 percent energy performance, incorporate recycled material, improve occupant comfort, and aid in mold prevention (*FOAMULAR® XPS Insulation*, 2022). Insulation materials are not specified in the case study, but high-performance insulation contributes to LEED credits and energy reduction by keeping the building cooler than traditional insulation.

The Building Rating System

The Tampa General Hospital Jennifer Leigh Muma Neonatal Intensive Care Unit is a LEED BD+C:NC v2.2 Gold-certified building that incorporated redevelopment of an existing building with new construction. To achieve this certification, a minimum of 39 points were needed in categories such as sustainable site planning, and indoor air quality. Like all projects, this project overcame hurdles to achieve its certification which can be documented as lessons learned.

LEED Points

According to USGBC Case Study (2012), points were earned for SSc2 and SSc4.1 by building at an urban site that has walk-able access to community services and public transportation. U.S. Green Building Council (2022) explains that SSc2 and 4.1 are worth up to 11 points. The author describes community services that must be located within a half of the site as including services such as banks, places of worship, fire stations, senior care facilities, and community centers. The project qualified for these points because the hospital is located in a densely populated urban area in South Tampa.

The SSc7.2 requirement earns points for buildings that utilize roofing materials with a minimum solar reflective index (SRI) (U.S. Green Building Council, 2022). TGH earned points for this requirement as well as additional designs that mitigated impacts of the surrounding environment. For example, control of building and site lighting resulted in points under credit SSc8 and designated reserved parking for high-efficiency vehicles earned the project points under credit SSc4.3, in addition to the roofing material's reduction of heat island effect (*USGBC Case Study*, 2012).

The project also earned a number of points under the indoor air quality category. USGBC Case Study (2012) states that the project earned points for credits IEQc1, 2, 6.1, 6.2, 7.1, and 7.2. These credits include designs that incorporate outdoor airflow as part of the HVAC system for patient comfort as well as indoor lighting and thermal controls that are able to be manipulated by individual occupants (U.S. Green Building Council, 2022; *USGBC Case Study*, 2012).

Lessons Learned

While the case study does not indicate the specific hurdles and lessons learned in this project, it is possible to make logical assumptions given the scope of the project. For example, while the builder, Skanska, worked with The Beck Group as their LEED consultant, it is possible that the submittal process was a stumbling block. If it was handled like one of Skanska's typical commercial projects rather than using a LEED-specific submittal process to navigate the added complexities. Gibney (2014) recommends LEED-specific submittal training to communicate how submittals should circulate and be reviewed. Without the proper process to review and track submittals for LEED compliance, the certification process can be delayed or points could be lost.

Additionally, incomplete or imprecise specifications that are not tailored to the project's specific LEED design can be a barrier. Gibney (2014) speaks to the importance of including thorough, well-coordinated specifications that are applied to the project by the LEEP AP and architect. The author states that generic terms like *recycled* do not necessarily mean the most sustainable materials. On the other hand, specifying, for example, a specific product manufacturer and item number and prohibiting substitutions can avoid later pitfalls with improperly specified materials.

The Problem With Single Green-Building Definition Criterion

Green-building certification authorities like LEED and Green Globes are helpful in providing the structure and guidance for sustainable construction. However, each certification authority is not without its own weaknesses. For example, energy performance in LEED buildings has been criticized as falling short of design targets. In fact, Amiri et al. (2019) referenced 44 peer-reviewed articles dealing with LEED building performance and discovered that there was not a consensus that LEED buildings were more sustainable than traditional construction, more beneficial for the environment, worth the money for the certification process, or that the certification in general is useful.

Newsham et al. (2009, as cited in Amiri et al., 2019) makes the point that one-third of LEED-certified buildings actually consume more energy than traditional buildings, and that there is no correlation between the buildings that conserve more energy and their LEED certification or score. However, the issue with relying on a single criterion to define green building lies in the difficulty to quantify the date. While LEED certification is intended to be an international standard, Amiri et al. (2019) noted the difficulty in finding comparable buildings in a variety of countries for comparison of energy data. For example, LEED certification relates to the use of site energy vs. source energy. Some countries, the author notes, “do not have the possibility of selecting energy type” (p. 11), as energy sources are under the control of governments or city councils.

In contrast, there are at least 20-times the number of Building Research Establishment Environmental Method (BREEAM) buildings as LEED buildings (Kibert, 2016). Unlike LEED credits, which are awarded based on designs and submittals, BREEAM buildings are awarded credits for when a building demonstrates performance levels for each area (Kibert, 2016). While LEED provides a framework for sustainable construction in design, BREEAM requires a demonstration of measurable sustainable performance metrics. For this reason, relying on a single criterion to define green buildings lacks the dimensionality that can be found in the consideration of multiple certification methods

Conclusion

Tampa General Hospital is a LEED BD+C:NC Gold-certified building in Davis Island, a suburb of Tampa. While many high-performance design features and materials culminated to result in the building’s Gold certification, three specific features implemented in this project include the reuse of the existing building, energy-efficient lighting, and the use of highly-reflective roofing materials. Individually and cumulatively, these designs have a positive impact on the environment, economy, and society as evidenced by such outcomes as a reduced heat island effect and reduced energy usage, lower operating costs, and increased patient comfort and accessibility. These outcomes are in line with the goals of sustainable construction.

While the case study does not always specify exact details, a variety of low-energy building strategies were incorporated in the design of TGH to garner the LEED BD+C:NC Gold certification and to reduce energy consumption by measurable amounts in a variety of areas. Strategies to reduce energy consumed by lighting include incorporating daylighting in the design and the use of smart technologies that limit or dim artificial lighting according to occupancy and ambient natural light. Strategies like this led to a 29 percent energy reduction for interior lighting at TGH. Highly-efficient HVAC systems that also incorporate smart technologies reduce the energy used for cooling the building, which can be significant in a humid subtropical region like Central Florida. While not specified in the case study, building energy simulation software could have helped the architect in an optimal design for intent and energy savings, while high-performance insulation could have contributed to reduced energy costs for cooling. Each of these high-performance energy design strategies are plausible, economical given the scale of the project, and would have contributed to the building's ultimate LEED certification.

While the various aspects of the LEED design garnered sufficient credits to result in a gold certification, not everyone agrees that LEED projects are worth the money or provide the sustainability results promised. Energy performance results in LEED projects are not always less than those of traditional construction. While LEED is a credible, substantial certification system for green building, it is not ideal to rely on a single source to define what makes a building sustainable, as other, performance-driven criteria can offer sensible alternative perspectives.

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