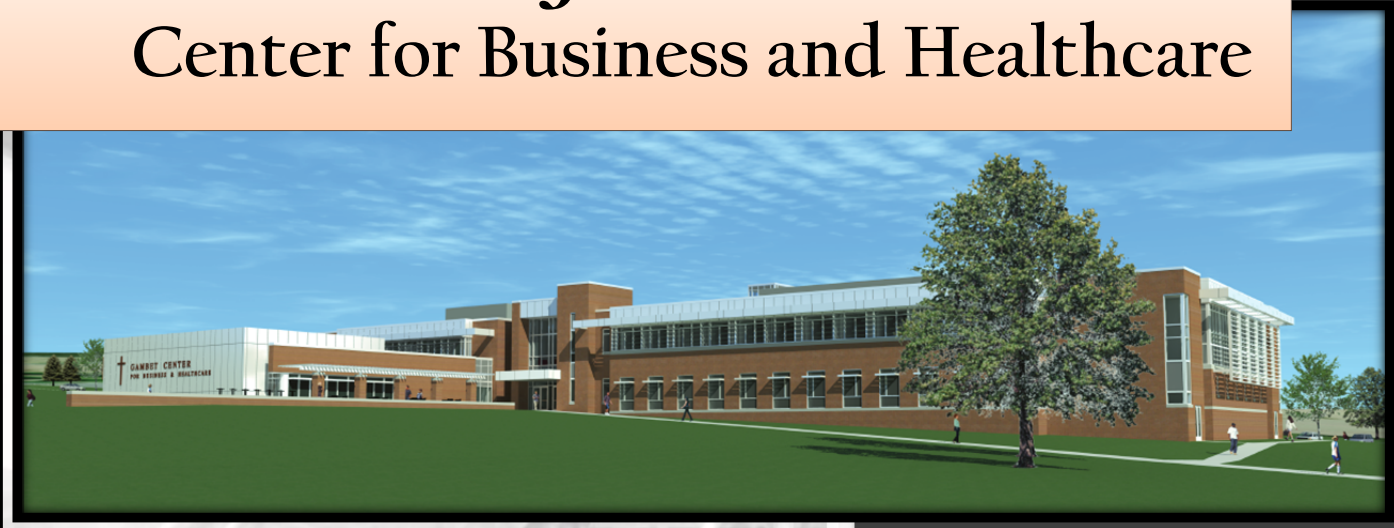
DeSales University

# Thesis Proposal

## Rev. James G. Gambet
## Center for Business and Healthcare

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# Executive Summary

The Reverend James G. Gambet Center for Business and Healthcare is the latest addition to the campus at DeSales University. The new $27 million facility, which is the new home of the Business, Nursing, and Physician Assistant Programs, will be state of the art and include technologically advanced labs and classrooms. DeSales' continual growth and ever increasing commitment to sustainability is reflected in the design of the facility, which is expected to achieve a LEED® Silver rating. The four analyses included in this proposal are to target specific ways in which to make the Gambet Center even more sustainable and able to upgrade the building to LEED® Gold classification.

***Technical Analysis 1: Building Information Modeling***

The first analysis aims to determine the advantages of incorporating the use of Building Information Modeling as a tool to aid in the design and operation of green buildings. With no BIM requirements set on the project, an analysis of how BIM techniques could have been utilized during the design process to influence sustainable systems and remain useful as the building becomes operational to track energy usage will be performed.

***Technical Analysis 2: Implementation of a Green Roof***

An alternate to the original design of the building included a large lecture hall that was eventually added to the scope of the project. A green roof structure for this part of the building will be considered to help offset the additional HVAC requirements, leading to a reduction in the large rooftop heat recovery units. A mechanical breadth will be conducted analyzing the impact the green roof has on the mechanical system loads with the intention increasing the energy efficiency of the building.

***Technical Analysis 3: On-Site Renewable Energy***

Without any on-site renewable energy on the project, a total of seven LEED® credits were not obtainable with the current design of the Gambet Center. This analysis will explore the feasibility of including photovoltaic panels on a significant portion of the roof surface of the building. Additional options such as wind-generated power will also be considered in order to maximize the on-site production of energy. An electrical breadth study will be conducted to analyze how these systems will connect and operate seamlessly with the existing electrical power system.

***Technical Analysis 4: More Advanced Lighting Control System***

The Gambet Center currently includes a basic lighting control system that only has the capability of switching lights on and off with switches, time clock controls, and occupancy sensors; however, there are no dimming capabilities, which require the light fixtures to use the maximum amount of energy when turned on. A system with dimming capabilities is expected to reduce energy consumption considerably. Also explored are automatic solar shades that are able to reduce mechanical loads, adding to the increased efficiency of the building.

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# Project Background

The Reverend James G. Gambet Center for Business and Healthcare is the latest addition to the campus at DeSales University. The new $27 million facility, which is the new home of the Business, Nursing, and Physician Assistant Programs, will be state of the art and include technologically advanced labs and classrooms. DeSales' continual growth and ever increasing quality in education has caused these programs to reach their maximum potential in the current facilities. Construction of the 77,000 square foot building is managed by Alvin H. Butz, Inc., and is scheduled to complete in November 2012.

Within the last five years, DeSales University has made a major push into education students and facilitating sustainable practices. Through combining the business and healthcare departments into one building, they are exposing the medical students to the business side of their industry, while providing them all with a new building that promotes sustainability and healthy lifestyles. The Gambet Center is expected to obtain a certification of LEED® Silver.

Currently, the Gambet Center is eligible for 50 LEED® credits, the minimum amount necessary for a LEED® Silver rating. An additional 10 credits are required for the building to achieve an upgraded rating of LEED® Gold. Of the available credits that are applicable to the Gambet Center, a focus on the energy efficiency and consumption of the building is essential to discover techniques in which LEED® Gold can be attained. It is the intent of the following four technical analyses to propose options in which a Gold rating can be made possible.

# Technical Analysis 1: Building Information Modeling

### *Problem Identification*

The use of Building Information Modeling (BIM) on the Gambet Center was limited, and had little impact on the project. These uses included the architect creating a 3D model to help determine building massing, the layout of important spaces, and to create renderings for marketing uses. In addition, the mechanical contractor also created a 3D model of the mechanical system to help realize complexities in construction of the mechanical and plumbing systems. Other than these basic implementations, BIM was not utilized on the project, and DeSales University has does not currently have any requirements for BIM in terms of record models for facilities management. It is possible other implementations of BIM could have been used to benefit the project and be used in the future by the facility managers to assist with operations over the building's lifecycle.

### *Background Research Performed*

The BIM Execution Guide developed by Penn State details a variety of ways BIM can be employed. Although it is obviously not appropriate to incorporate every use into the Gambet Center, it can be beneficial to analyze a few. A list of various BIM uses from the Penn State BIM Execution Planning Guide are listed below:

**BIM Uses:**

| | |
|---|---|
| Building Maintenance Scheduling | Digital Layouts |
| Building Systems Analysis | 3D Coordination |
| Asset Management | Engineering Analysis |
| Space Management and Tracking | Facility Energy Analysis |
| Disaster Planning | Structural Analysis |
| Record Modeling | Sustainability Evaluation |
| Site Utilization Planning | Code Validation |
| Virtual Mockups | Cost Estimation |
| Digital Fabrication | Phase Planning |
| Programming | Design Reviews |
| Site Analysis | Existing Conditions Modeling |

Again, it is not logical to incorporate all of these uses on every project, and final decisions rely on the uses providing the most benefit to the owner or project team.

### *Potential Solutions*

As DeSales University continues to expand their campus in a sustainable manner, it may prove to be beneficial to begin implementing BIM to help manage and maintain their facilities, while also providing benefits during the design and construction process. These implementations include creating high-detail 3D models of the mechanical system to determine conflicts in the field with other building systems, running an energy use analysis to achieve faster return on investment, and conduct energy assessments for facility managers.

### *Methodology*

- Contact Alvin H. Butz, Inc. to determine how they have utilized BIM on other projects
- Contact DeSales University Facilities Management to learn of future plans of incorporating BIM on campus
- Contact H.T. Lyons, the mechanical contractor, to determine specifically how their 3D model benefited the construction process on this project and how it could have been improved
- Perform case studies on other projects that used BIM to gain insight on cost impact, productivity increases, and other benefits
- Interview industry professionals to understand how to start using BIM and the cost implications
- Interview construction workers to determine how BIM has helped them in their job
- Meet with University resources to learn more about each of the BIM uses and how Penn State began using BIM with facility management

### *Expected Outcome*

It is expected that the initial investment of setting BIM requirements on the project would aide in the construction process by resolving conflicts before installation in the field, leading to a reduced amount of change orders and acceleration of the schedule. This is also believed to be beneficial to the project in terms of sustainability, where the most energy efficient system with the highest return on investment can be properly chosen in the design phase. Energy usage monitoring can also be incorporated after the building is turned over in order to help the owner to continue to achieve their goals of remaining a leader in sustainability.

# Technical Analysis 2: Green Roof Implementation

### *Problem Identification*

The Lecture Hall was initially an alternative option to the initial design of the Gambet Center that was eventually included in the project scope. This alternate requires two additional rooftop heat recovery units, the implementation of a green roof may allow for a reduction in the size of the mechanical system for the additional space.

### *Background Research Performed*

Green roofs have become increasingly popular in green building design due to their exceptional performance as building insulation and can substantially reduce building loads. Green roofs consist of many layers and are partially covered with soil and small plant life. These layers include waterproofing, water drainage, soil retention, and soil among others. Other advantages to incorporating green roofs are for absorption/collection of rainwater, a small habitat for wildlife, and mitigation of the heat island effect. Although a higher initial cost and more difficult to construct, green roofs can provide durable roof membranes that can save the owner money in the long run.

### *Potential Solutions*

While the addition of a green roof does not have a direct effect on helping the Gambet Center achieve a higher LEED® rating, it may have a significant reduction to the mechanical load of the building that, when paired with an alternative geothermal mechanical system, helps to optimize the energy performance of the building.

### *Methodology*

- Research variations of green roofs to determine which types would be the most appropriate to use on the project
- Contact manufacturers of green roofs to understand design and implications of green roofs on other systems
- Analyze how green roof affects energy consumption of the building and compare to current energy usage
- Perform a lifecycle cost analysis of implementing a green roof and determine feasibility of inclusion on the project
- Determine schedule impacts of green roof construction

### *Expected Outcome*

It is believed that the addition of a green roof system above the Lecture Hall will substantially reduce the heating/cooling load on the space, leading to a reduction of the mechanical equipment needed. This will lead to a higher energy performance for the building and help with the attainment of LEED® points to receive a Gold rating. After this analysis, it may be shown

that the incorporation of a green roof on the majority of the roof structure is more beneficial than a photovoltaic system application in terms of achieving LEED® points.

# Technical Analysis 3: On-Site Renewable Energy

### *Problem Identification*

DeSales University has made major strides in incorporating sustainable practices into their campus operations, most notably in the construction of their new buildings. The McShea Student Center was the first LEED® Accredited building on the campus, and is followed by the Gambet Center, both of which meet LEED® Silver requirements. Rewarded for leadership in sustainability, DeSales has the opportunity to take that role even farther by starting to incorporate energy independence into its practices. Photovoltaic and green technologies can be explored to help DeSales remain a leader in the area, while also showing a strong commitment to sustainability.

### *Background Research*

Photovoltaic solar panels are the most popular way to produce electricity on site, and help offset energy use in buildings. In depth research will be required to discover cost effective technology that is appropriate for use on the Gambet Center. Additional ways of generating electricity, such as wind turbines and "stand-alone" PV panels, can also be evaluated. Lowering the amount of energy consumed by the Gambet Center is one of the best ways to make it more sustainable because it decreases the reliance on the utility, because generation of electricity is a major contributor to greenhouse gas emissions.

### *Potential Solutions*

The installation of PV arrays on the roof of the Gambet Center will produce the most amount of electricity, but a cost to benefit analysis will need to be performed to determine how much of the roof area should be covered with solar panels, or if this type of system is feasible at all. A smaller application, such as small wind turbines on the tops of exterior light poles may also be a unique way to produce electricity on site.

### *Methodology*

- Research photovoltaic applications in similar buildings
- Research unique "stand-alone" PV applications such as solar trees on the site and PV glass panels
- Calculate energy usage as currently designed to determine baseline energy usage of the building
- Research into PV array design to calculate generation capacity and cost
- Conduct a lifecycle cost analysis and return on investment to compare to the owner's expectations
- Analyze how PV systems connect with the current electrical power system
- Make recommendation on feasibility of PV system

***Expected Outcome***

It is expected that inclusion of a PV array on a significant portion of the roof area will be a viable application to reduce energy costs. The lifecycle analysis will detail the return on investment and be compared to the owner's expectations on what they are willing to invest to make a recommendation whether or not this solution is appropriate to help gain LEED® points. Depending on the results from Technical Analysis 2, rooftop PV arrays may not be the most beneficial for gaining additional LEED® points, in which case other applications of on-site renewable energy will be explored.

# Technical Analysis 4: Advanced Lighting Controls

### *Problem Identification*

While the Gambet Center was specifically designed with sustainability in mind, the initial cost and payback period to the owner were major factors in deciding what types of systems to use on the project. A basic lighting control system was included to help reduce energy consumption. While this system was designed to be energy conscious, it is not the most efficient system that could have been chosen. The largest opportunity to gain additional LEED® points are available when optimizing the energy performance of the building, so a more advanced lighting control system can help to make this possible.

### *Background Research Performed*

The current lighting control system is a Lutron Electronics computer processor based system known as Quantum. Quantum has the ability to become an advanced lighting control system, but as it is currently designed, the Gambet Center does not take advantage of this functionality. As an example, the lights can only be switched on and off, with no dimming capability built in. Without the ability to dim lights, they will be using more electricity than if they could be dimmed most of the time.

### *Potential Solutions*

By upgrading some of the components of the Quantum light management system already in place in the Gambet Center, a considerable amount of energy can be saved by adding dimming and other automatic control capability.

### *Methodology*

- Determine baseline energy consumption of lighting system as currently designed
- Redesign lighting control system to reduce electricity needed
- Analyze minimum lighting levels needed in order to meet code
- Calculate energy saved through dimming lights and using automatic controls
- Research more efficient light fixtures to further reduce energy consumption
- Compare both initial and lifecycle costs of the original and alternative system
- Research automatic shading solutions and their impact on mechanical load

### *Expected Outcome*

It is believed that a more advanced lighting control system with efficient fixtures will benefit the Gambet Center in terms of sustainability. The energy savings of the upgraded Quantum system are expected to outweigh the higher initial costs. It is also thought the additional shading solution will help reduce the mechanical loads of the building, further increasing the efficiency.

# Analysis Weight Matrix

The four technical analyses proposed on the Gambet Center integrate four primary areas, which include Critical Issue Research, Value Engineering, Constructability Review, and Schedule Reduction/Acceleration. Table 1, illustrated below, evaluates the weighted values of each study and the relation between the primary areas discussed above.

| Technical Analysis Weight Matrix for the Distribution of the Core Investigation Areas | | | | | |
|---|---|---|---|---|---|
| Description | Research | Value Engineering | Constructability Review | Schedule Reduction/ Acceleration | |
| **Use of BIM** | 10% | - | 5% | 10% | 25% |
| **Green Roof** | 5% | 15% | 10% | - | 30% |
| **On-Site Renewable Energy** | 10% | 10% | 10% | - | 30% |
| **Advanced Lighting Controls** | 5% | 10% | - | - | 15% |
| **Total** | 30% | 35% | 25% | 10% | 100% |

Table 1: Analysis Weight Matrix

# Conclusion

Upon completion of the four technical analyses described above, it will be determined if the implementations of sustainable concepts and systems will be enough for the Gambet Center to gain the additional 10 LEED® credits necessary for Gold rating. Technical Analysis 1 will explore how the facility can benefit through using a higher level of BIM in the project in regard to energy use modeling and tracking. Investigation of a green roof for the lecture hall to reduce mechanical loads will be conducted in Technical Analysis 2 with the intention of substantially reducing the size of rooftop HVAC equipment for the lecture hall. Technical Analysis 3 is expected to show that a small portion of the building's electrical consumption can come from on-site renewable energy in the form of photovoltaic panels on the roof. Finally, the redesigned lighting control system explored in Technical Analysis 4 is expected to considerably reduce the electric consumption of the lighting system. The combination of these four technical analyses is believed to make the difference between a LEED® Silver and Gold rating.

# | Appendix A |

## Breadth Studies

# Breadth Studies

### *Mechanical Breadth*

The addition of a green roof over the lecture hall will substantially decrease the mechanical load of the space. Two rooftop heat recovery units are curently needed, but will not be necessary after the green roof is implemented. A recalculation of the mechanical loads will be conducted, which will lead to a reduction in the size of the mechanical system. This savings will be compared to the cost of the green roof in order to accurately define the return on investment.

### *Electrical Breadth*

An electrical breadth pertaining to Technical Analysis 3 will involve designing and sizing the equipment needed for connecting the photovoltaic system into the existing electrical system. Optimal location for inverters will be determined, as well as the sizing of feeders between inverters, solar panels, and the switchgear located in the mechanical room. An examination of how the renewable power will tie into the switchgear will also be necessary, focusing on any constructibility concerns that may apply.

# | Appendix B |

## Preliminary Thesis Schedule

Brett Tallada
Rev. James G. Gambe Center

# SPRING 2013 THESIS TIMELINE

| JAN-7-13 | JAN-14-13 | JAN-21-13 | JAN-28-13 | FEB-4-13 | FEB-11-13 | FEB-18-13 | FEB-25-13 | MAR-4-13 | MAR-11-13 | MAR-18-13 | MAR-25-13 | APR-1-13 | APR-8-13 | APR-15-13 | APR-22-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RESEARCH BIM USES | | | | | | | | SPRING BREAK | | | | | FINAL REPORTS DUE | FACULTY JURY PRESENTATIONS | AE SENIOR BANQUET |
| | | CONDUCT INTERVIEWS | | | | | | | | | | | | | |
| | | | | ANALYZE SPECIFIC BIM USES | | | | | | | | | | | |
| | | | | | | SUSTAINABILITY | | | ANALYSIS | | | | | | |
| | | | | | | | | | IMPLEMENTATION STUDY | | | | | | |
| | | | | | | | | | | DEVELOP REPORT/PRESENTATION | | | | | |
| RESEARCH GREEN ROOF TERRACE TYPES | | | | | | | | | | | | | | | |
| | DESIGN CONSULTATION | | | | | | | | | | | | | | |
| | | PRELIMINARY GREEN ROOF DESIGN | | | | | | | | | | | | | |
| | | | | MECHANICAL BREADTH ANALYSIS | | | | | | | | | | | |
| | | | | | INITIAL AND LIFECYCLE COST | | | | | | | | | | |
| | | | | | | | | | IMPLEMENTATION STUDY | | | | | | |
| RESEARCH PHOTOVOLTAIC AND OTHER RENEWABLE SYSTEMS | | | | | | | | | | DEVELOP REPORT/PRESENTATION | | | | | |
| | | ANALYZE BUILDING ENERGY CONSUMPTION | | | | | | | | | | | | | |
| | | | DESIGN AND CALCULATE GENERATION CAPACITY | | | | | | | | | | | | |
| | | | | | ELECTRICAL BREADTH ANALYSIS | | | | | | | | | | |
| | | | | | | INITIAL AND LIFECYCLE COST | | | | | | | | | |
| | | | | | | | | | FEASIBILITY ANALSIS | | | | | | |
| | | | | | | | | | | DEVELOP REPORT/PRESENTATION | | | | | |
| CALCULATE LIGHTING LOADS | | | | | | | | | | | | | | | |
| | CALCULATE MINIMUM LIGHT LEVELS | | | | | | | | | | | | | | |
| | | REDESIGN LIGHTING CONTROL SYSTEM | | | | | | | | | | | | | |
| | | | CALCULATE ENERGY SAVINGS | | | | | | | | | | | | |
| | | | | | RESEARCH MORE EFFICIENT FIXTURES | | | | | | | | | | |
| | | | | | | LIFECYCLE COST | | | ANALYSIS | | | | | | |
| | | | | | | | | | | DEVELOP REPORT/PRESENTATION | | | | | |

| | |
|---|---|
| | Technical Analysis 1: Building Information Modeling |
| | Technical Analysis 2: Green Roof Implementation |
| | Technical Analysis 3: On-Site Renewable Energy |
| | Technical Analysis 4: Advanced Lighting Controls |