DeSales University

Thesis Proposal

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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. This will include research into how the building industry measures energy and how to apply these measurements to accurately model energy usage using BIM.

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. In addition, a structural breadth study will also be performed on the structural system of the Gambet Center to determine any changes necessary to support the added load of the green roof.

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 requires 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

*Critical Industry Issue

Problem Identification

The use of Building Information Modeling (BIM) on the Gambet Center was limited, and had little impact on the project as a whole. 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.

Discussion of energy usage and BIM at the 2012 PACE Roundtable provided insight into the problems of utilizing BIM for energy modeling. Research into what makes a valuable energy model and how to make the model work best for designers and facility managers and how to interface this information with the Building Automation System will be performed.

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, and what type of information would be most useful to them for energy tracking and facility management
- 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
- Evaluate BIM limitations for energy modeling and tracking, and propose possible solutions to interfacing with BAS
- Perform case studies on other projects that used BIM to gain insight on cost impact, productivity increases, and other benefits to facility management
- 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 BIM uses and how Penn State began using BIM with facility management, and how they see BIM integration evolving in the future

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 give the facility managers more automated control over the building, while allowing 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 loads

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.

Weight Matrix

Technical Analysis Weight Matrix for the Distribution of the Core Investigation Areas					
Description	Critical Industry Research	Value Engineering	Constructability Review	Schedule Reduction/ Acceleration	Total
Use of BIM	20%	-	5%	10%	**35%**
Green Roof		15%	10%	-	**25%**
On-Site Renewable Energy		10%	15%	-	**25%**
Advanced Lighting Controls		15%	-	-	**15%**
Total	**20%**	**40%**	**30%**	**10%**	**100%**

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-1 |

Breadth Studies

Breadth Studies

Structural Breadth

The implementation of sustainable technologies into the Gambet Center includes the addition of a green roof system above the Lecture Hall, which is evaluated in Technical Analysis 2. The incorporation of a green roof imposes a significantly larger dead load on the structure, and a closer look must be taken into the effects on the structural system. It is expected that the structural system that is currently designed will not be adequate, and fail to resist the additional load from the green roof.

Depending on the outcome of the breadth analysis it will be apparent whether it is necessary to either increase or not change the size of the structural members. In the probable case the size of the structural system increases, the cost implications will be considered and compared to those of the rest of the system. While there are substantial costs associated with green roofs, the size of the mechanical system will decrease leading to cost savings on heating and cooling costs over time. A lifecycle cost analysis of adding the green roof will also be conducted to assess whether the payback period is within the expectations of the owner. Regardless of the cost of the system, any gains in building efficiency will help to achieve more LEED® points for obtaining Gold certification.

Mechanical Breadth

Also stemming from Technical Analysis 2, a mechanical breadth will also be performed to calculate the amount of energy saved from the addition of a green roof system above the Lecture Hall. As it is currently designed, the Lecture Hall requires two 2,850 CFM air-handling units for mechanical loads. Since green roofs are excellent at providing insulation, they can largely reduce the heating and cooling loads of the Lecture Hall.

The savings in cost could potentially come from a combination of using less natural gas through energy reduction and the need for smaller equipment. As stated above these savings will be compared to the additional costs of the green roof itself and the necessary upgrades to the structural system, and used to provide the owner with a complete lifecycle cost analysis of implementing a green roof.

Electrical Breadth

The additions of photovoltaic and other on-site renewable energy generation systems have the potential to decrease electricity usage in the building considerably. Combined with a more efficient lighting control system, the possibility of providing a higher percentage of the buildings electricity through renewables becomes more achievable. However, it is also important to consider how these systems will interface with the currently designed electrical system in the building.

The complete design of the renewable system will be completed. Optimal location for locating solar panels and inverters will be determined as well as feeder sizes between solar panels, inverters, and switchgear in the mechanical room. Any constructability concerns with the installation of the renewable energy system will also be analyzed with possible solutions proposed.

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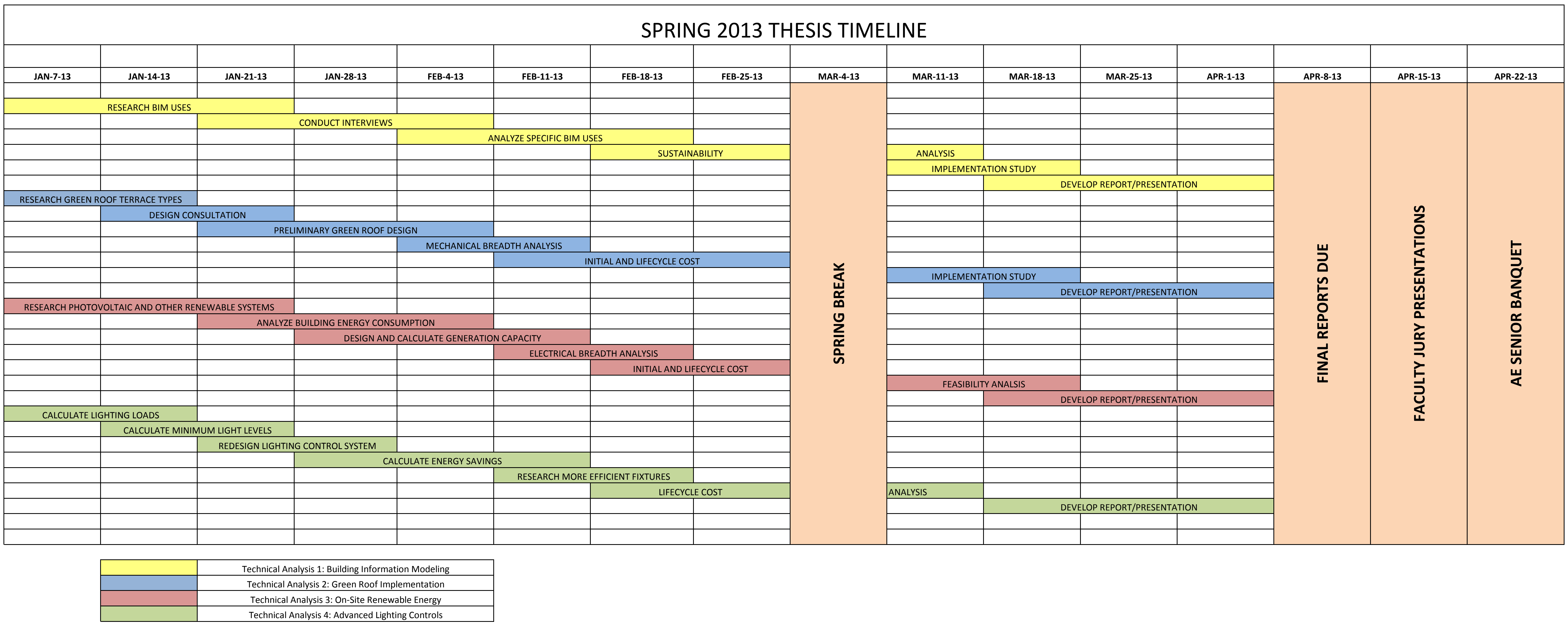
Preliminary Thesis Schedule


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
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
DEVELOP REPORT/PRESENTATION
RESEARCH PHOTOVOLTAIC AND OTHER RENEWABLE SYSTEMS
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
SPRING BREAK
FINAL REPORTS DUE
FACULTY JURY PRESENTATIONS
AE SENIOR BANQUET
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