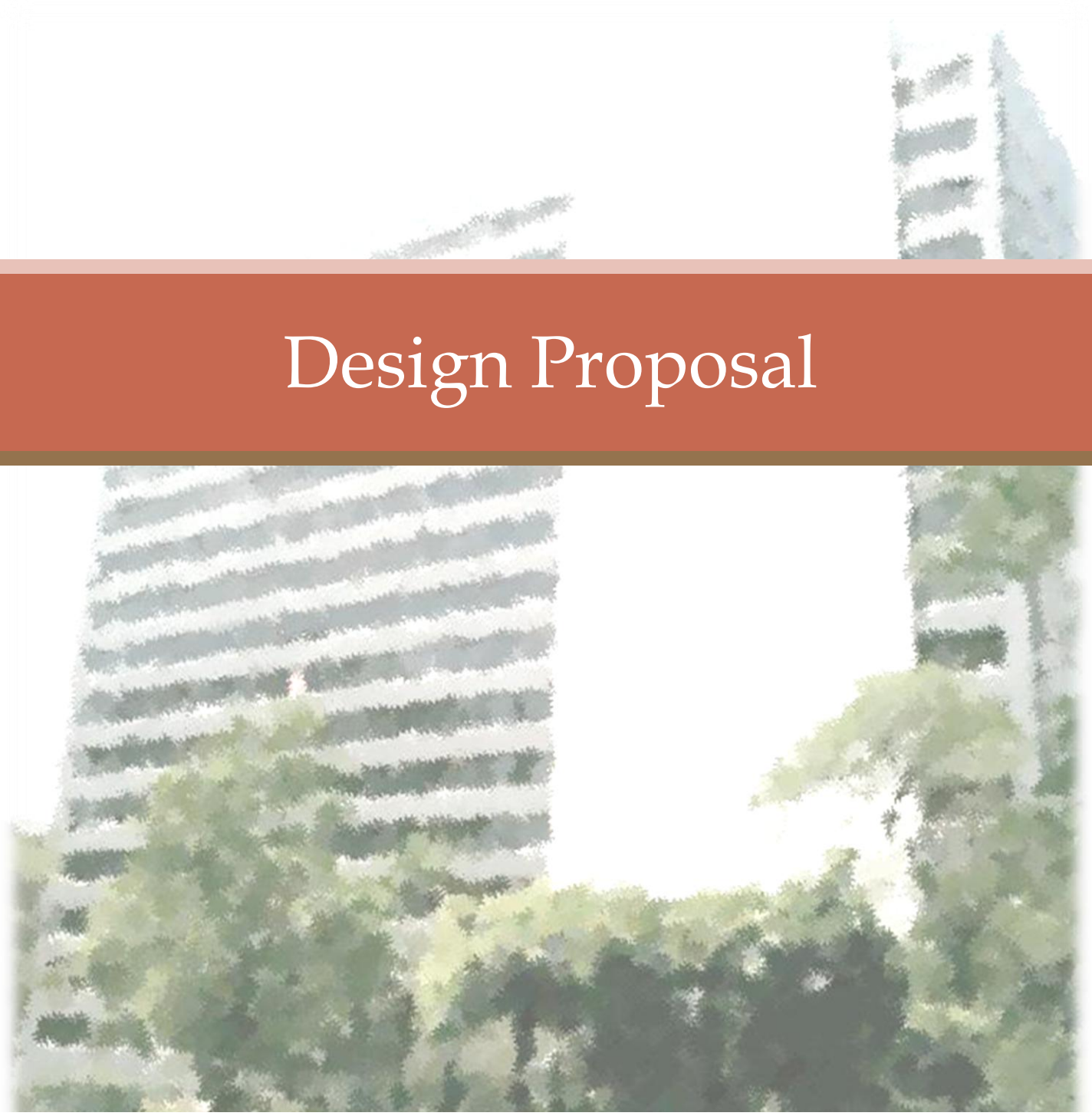
Design Proposal



RIVER VUE APARTMENTS, PITTSBURGH, PA

December 9, 2011
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Design Proposal

River Vue Apartments, Pittsburgh, PA

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Executive Summary

A formal design proposal will serve as a guide and schedule to modify the current design of River Vue Apartments throughout the Spring 2012 semester. A large depth study will be conducted in the area of mechanical systems design while two breadth studies will focus on other areas of the Architectural Engineering program, such as lighting/electrical and construction management, to emphasize the importance of integrated design.

As noted in Technical Reports 1, 2, and 3, there are several aspects of the current design that do not meet current ventilation or energy standards and therefore prevent River Vue Apartments from being a leading building in energy performance. The building receives low amounts of ventilation air, uses highly repetitive heat pumps in each of the apartment units and suffers from high solar gains due to excessive glazing on the façade. Although the construction process will be highly organized and implement regional materials and recycling programs, River Vue Apartments barely achieves LEED Certified status and may contribute to the urban heat island effect.

In order to improve the building's energy usage, the building's current heat pumps will be removed to allow for re-zoning of the interior spaces. Demand control ventilation will be implemented using high velocity air streams and CO_2 sensors to monitor occupancy and regulate ventilation more accurately. The current make-up air handling unit will be resized or replaced to manage this system and small supply air ducts will be designed for central corridor distribution.

The first breadth study will examine the installation of a photovoltaic array for the roof and if the net electric consumption for the building can be reduced. These panels may improve the energy usage and sustainability points of River Vue apartments while allowing for internal shading devices to be implemented to reduce solar gains.

A second breadth study will focus on the scheduling and cost impacts of changing the mechanical system and controls, as well as the addition of the photovoltaic array and corresponding electrical components. This study will be preparation for my potential career as a project manager for a mechanical contracting firm.

Background Information

River Vue Apartments is a renovation project to turn the Old State Office Building located downtown Pittsburgh, Pennsylvania into a high rise multifamily apartment complex. The site is tightly constrained by neighboring buildings and historic sites and most of the existing structure will remain with the exception of fenestration which will be replaced to lighten the solar gains.

Ventilation is provided by the single make up air handling unit whereas heating and cooling is supplied by heat pumps located in each apartment unit. Loop water serves the heat pumps and a chilled water loop provides water for domestic use. Minimal floor space is lost on each floor due to mechanical equipment and shafts.

Construction spans over a time period of approximately ten months and involves the demolition of all existing interior work, installation of new mechanical, electrical and plumbing systems as well as new finishes, site work, and balconies for units on upper floors. The guaranteed maximum price of $28 million allows little room for energy modeling or energy usage tracking however, LEED Certified status will be achieved through the use of regional and recycled materials, reuse of the project site and detailed management and commissioning of the project from construction through project delivery.

Existing Conditions

Several aspects of the construction project discovered throughout research in Technical Reports 1, 2, and 3 that were less than satisfactory include the following:

- Insufficient ventilation supply air in many internal spaces
- No occupancy sensors for ventilation control
- High solar loads from excessive fenestration
- No energy storage
- Low thermal mass in structure
- Building contributes to urban heat island effect

Understanding these concerns lead to the development of several alternatives for the redesign of the mechanical system.

Depth Design Alternatives

Demand Control Ventilation

High velocity air can be provided from the make-up air handling unit while occupancy sensors regulate the amount of ventilation provided. This scheme may require the rezoning of interior spaces and resizing or replacement of the existing AHU. CO_2 occupancy sensors could be integrated into the new control system for accurate ventilation at all times.

Absorption Chiller

The addition of an absorption chiller could be used to produce thermal storage in the form of ice. High boiler water temperature is necessary to produce water hot enough to have excess heat for absorption however, if solar collectors are used thermal storage could be supplemented. Additional structural support will likely be necessary due to the added weight of the equipment.

Radiant Slabs with DOAS

Radiant slabs will provide sensible heating or cooling for the building's zones while a dedicated outdoor air system would supply necessary ventilation air. This scheme would require changes to the current water loop and control systems.

Geothermal Loop

A closed geothermal loop, connected to a heat pump at both ends, can be inserted into a long well in the site surrounding River Vue Apartments to take advantage of constant ground temperatures. Since geothermal systems often require multiple loops of great lengths, this option seems the least attractive with the confined city site.

Note: Although only one design alternative was chosen for the purpose of this proposal, it may become evident through further research that additional design alternatives are necessary. Therefore, the list above will remain in full consideration until further study can be conducted.

Proposed Depth Redesign

Applying a demand control ventilation system with high velocity air supply and CO_2 occupancy sensors for added control will provide the potential to save supply fan energy while improving indoor air quality and reducing operating costs. There is little room for additional ductwork in the existing ceiling plenum therefore a single; central-hallway distribution will be implemented. An analysis of the payback period will be influential in determining if this redesign is cost-effective.

Tasks

1. Research DCV System & CO2 Sensors
2. Rezone building spaces
3. Adjust size of make-up air unit (or replace) and add modulating dampers
4. Select CO2 occupancy sensors for building and assign locations for placement
5. Size new ductwork and diffusers based on ASHRAE Standard 62.1
6. Layout new ductwork and diffusers

Tools

- Demand Control Design Guide by Carrier
- Demand Control Design Guide produced by the Oregon Office of Energy
- ASHRAE Standards 62.1 and 90.1
- ASHRAE Book of Fundamentals

Proposed Breadth 1

An electrical investigation will consider implementing a photovoltaic array on the roof of the building to improve net electric consumption and achieve further sustainability points for River Vue Apartment's LEED Score. The electricity generated from the array can supplement the needs of the building to reduce the total annual demand and potentially power internal shading devices that can shield the building from high solar gains.

Tasks

1. Research photovoltaic systems
2. Select panels and sizing
3. Layout array
4. Size corresponding wiring, panelboard, etc.

5. Investigate payback period
6. Research internal shading devices
7. Create summary

Tools

- AE 456 lecture materials and course text book
- Building Integrated Photovoltaic Designs for Commercial and Institutional Structures: A Sourcebook for Architects
- National Electric Code

Proposed Breadth 2

Since I have a professional interest in becoming a project manager for a mechanical contractor, a construction management study consisting of a cost estimate, schedule changes and the sustainability impact of adding demand control ventilation and a photovoltaic array would be beneficial. A bid package for the addition of the new mechanical equipment and material will be produced.

Tasks

1. Equipment and material takeoff
2. Equipment and material pricing
3. Create bid package
4. Estimate delivery, installation, and start-up times& develop new project schedule
5. Create Summary

Tools

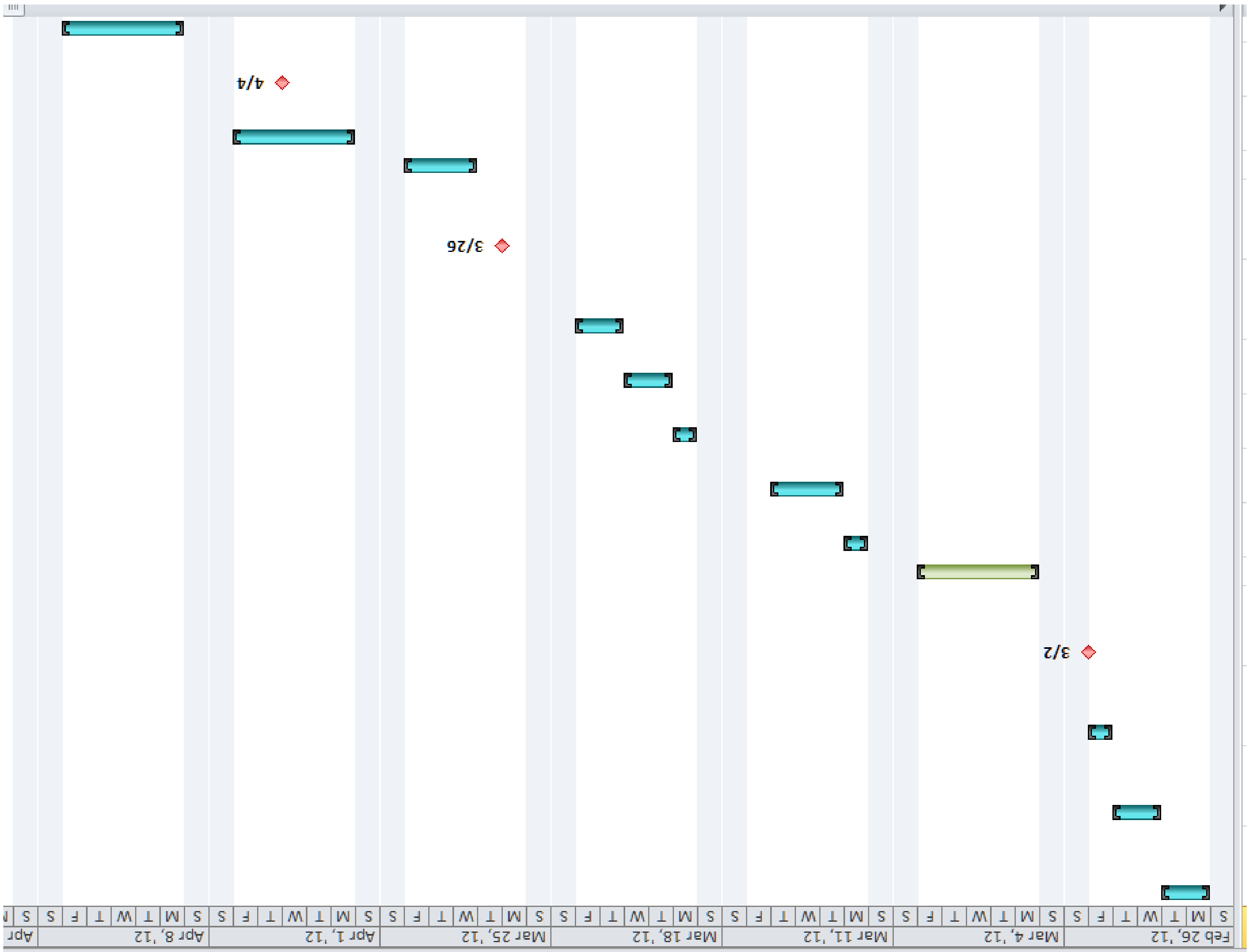
- R.S. Means Catalogs
- Equipment manufacturer catalogs
- Microsoft Excel
- Microsoft Project

List of Tasks

Task Name	Duration	Start	Finish
Semester Begins	1 day	Mon 1/9/12	Mon 1/9/12
Revise Proposal	5 days	Mon 1/9/12	Fri 1/13/12
Depth Task 1 - Research DCV	2 days	Wed 1/11/12	Thu 1/12/12
Depth Task 1 - Research CO2 Sensors	2 days	Thu 1/12/12	Fri 1/13/12
Depth Task 2 - Rezone Spaces	1 day	Mon 1/16/12	Mon 1/16/12
Depth Task 3 - Adjust AHU	3 days	Mon 1/16/12	Wed 1/18/12
ASHRAE Winter Conference	5 days	Sat 1/21/12	Thu 1/26/12
Depth Task 4 - Select CO2 Sensors	2 days	Thu 1/26/12	Fri 1/27/12
Milestone 1 - Revised Proposal Posted	1 day	Fri 1/27/12	Fri 1/27/12
Depth Task 5 - Size new ductwork, diffusers	5 days	Mon 1/30/12	Fri 2/3/12
Depth Task 6 - Layout new duct	5 days	Mon 1/30/12	Fri 2/3/12
Assemble Depth Report	3 days	Mon 2/6/12	Wed 2/8/12
Breadth 1 - Task 1 - Research PV Systems	2 days	Thu 2/9/12	Fri 2/10/12
My Birthday	1 day	Sun 2/12/12	Sun 2/12/12
Milestone 2 - Completion of Depth Study 1	1 day	Mon 2/13/12	Mon 2/13/12
Breadth 1 - Task 2 - Select Panels & Sizing	3 days	Wed 2/15/12	Fri 2/17/12

Breadth 1 - Task 3 - Layout Array	1 day	Mon 2/20/12	Mon 2/20/12
Breadth 1 - Task 4 - Size Corresponding Electrical Components	2 days	Wed 2/22/12	Thu 2/23/12
Breadth 1 - Task 5 - Investigate Payback Period	2 days	Mon 2/27/12	Tue 2/28/12
Breadth 1 - Task 6 - Research Internal Shading Devices	2 days	Wed 2/29/12	Thu 3/1/12
Breadth 1 - Task 7 - Write Breadth 1 Summary	1 day	Fri 3/2/12	Fri 3/2/12
Milestone 3 - Completion of Breadth Study 1	1 day	Fri 3/2/12	Fri 3/2/12
Spring Break	5 days	Mon 3/5/12	Fri 3/9/12
Breadth 2 - Task 1 - Takeoffs	1 day	Mon 3/12/12	Mon 3/12/12
Breadth 2 - Task 2 - Pricing	3 days	Tue 3/13/12	Thu 3/15/12
Breadth 2 - Task 3 - Develop Bid Package	1 day	Mon 3/19/12	Mon 3/19/12
Breadth 2 - Task 4 - Schedule Changes	2 days	Tue 3/20/12	Wed 3/21/12
Breadth 2 - Task 5 - Create Breadth 2 Summary	2 days	Thu 3/22/12	Fri 3/23/12
Milestone 4 - Completion of Breadth Study 2	1 day	Mon 3/26/12	Mon 3/26/12
Assemble Final Paper	3 days	Wed 3/28/12	Fri 3/30/12
Assemble Final Presentation	5 days	Mon 4/2/12	Fri 4/6/12
Milestone 5 - Final Report Due	1 day	Wed 4/4/12	Wed 4/4/12
Final Presentations	5 days	Mon 4/9/12	Fri 4/13/12
ABET Evaluations	1 day	Mon 4/16/12	Mon 4/16/12
CPEP Finalizations	2 days	Thu 4/19/12	Fri 4/20/12
Semester Ends & Senior Banquet	1 day	Fri 4/27/12	Fri 4/27/12
Graduation	1 day	Fri 5/4/12	Fri 5/4/12

Gantt Chart Schedule


Feb 26, '12
Mar 4, '12
Mar 11, '12
Mar 18, '12
Mar 25, '12
Apr 1, '12
Apr 8, '12
Apr
3/2
3/26
4/4


Apr 1, '12
Apr 8, '12
Apr 15, '12
Apr 22, '12
Apr 29, '12
May 6, '12
4/4
4/27

Preliminary Research

Demand Control Ventilation

1. http://demandcontrolventilation.com/
2. Demand-Control Ventilation Design Guide (Oregon Office of Energy) http://www.oregon.gov/ENERGY/CONS/BUS/DCV/docs/DCVGuide.pdf?ga=t
3. Holmberg, David. (November 2011). Demand Response and Standards. *ASHRAE Journal*, pages B23-B35.
4. John, David. (September 2011). Designing for Comfort. *ASHRAE Journal*, pages 38-47.
5. Shapiro, Ian. (October 2011). HVAC Selection for Envelope-Dominated Buildings. *ASHRAE Journal*, pages 30-40.
6. Turner, Stephen. (June 2011). What's New in ASHRAE's Standard on Comfort. *ASHRAE Journal*, pages 42-48.

Geothermal Loops

1. http://www.eagle-mt.com/geomax/geothermal_loops.php

Absorption Chiller

1. McQuiston, Parker & Spitler. (2005). Heating, Ventilating, and Air Conditioning Analysis and Design. Sixth Edition.
2. Wang, Kai and Vineyard, Edward. (September 2011). Absorption Refrigeration. *ASHRAE Journal*, pages 14-24.

Photovoltaic Arrays

1. http://www.wbdg.org/resources/bipv.php
2. Bushby, Steven. (November 2011). Information Model Standard for Integrating Facilities with Smart Grid. *ASHRAE Journal*, pages B18-B22.
3. Newell, Ty and Newell, Ben. (June 2011). Solar Collection and Use. *ASHRAE Journal*, pages 72-77.

Concluding Remarks

This proposal is a first draft and should be considered a work-in-progress. The tasks and schedule for each study outlined are subject to change as further research is completed. The goal of each design proposal is to conserve net energy usage, improve sustainability, reduce building emissions, and promote integrated design techniques. Architectural engineering is about considering all possibilities and merging the best design strategies to create an efficient, beautiful product.

Acknowledgements

Thank you to the following people:

- My adviser, Stephen Treado, for his help in editing my technical reports and providing professional consulting
- My friends and family for their continued support throughout my senior year.