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# Thesis Proposal

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Final Proposal for  
Spring Thesis Project

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## Executive Summary

This report serves as a proposal for my spring senior thesis work. The semester will be spent researching, finding viable solutions to problems, and forming conclusions based on cost analysis, construction feasibility, schedule impacts, and value engineering. The theme for my thesis is adding value to the Washington Christian Academy by incorporating healthy, sustainable features into the building. Research has shown that students perform better when they are in classrooms with improved indoor air quality, better acoustics, and increased natural light. These points will serve as the foundation for my thesis research. The research analyses I intend to study in the spring are as follows:

### Analysis 1: Consequences of the English-Spanish Language Barrier at the Jobsite

#### *Critical Industry Issue*

This analysis focuses on a critical industry issue which plagues the Washington, DC construction industry. The focus of the analysis will be on identifying the top five problems on a typical jobsite related to this barrier. The goal is to identify these challenges and address solutions to remedy them.

### Analysis 2: Improve Indoor Air Quality

#### *Mechanical Breadth*

Analysis two addresses one of the three environmental factors discussed above. This analysis is based on researching and implementing a higher quality air filtration system into the mechanical system. The goal of this analysis to address the benefits of improved indoor air quality, improve the indoor quality by adding filters, analyze cost and construction constraints, and determine if prefabrication is available. This value engineering idea will have to be marketed to the owner based on value and life cycle cost savings.

### Analysis 3: Better Acoustics

#### *Acoustical/Mechanical Breadth*

The second environmental factor that improves schools is addressed in this analysis. This analysis will focus on improving the acoustics in the gymnasium, which is a large open space with sheet metal ductwork. This ductwork will be replaced with fabric duct. The system will be analyzed from a cost, interior sequence schedule, and procurement/availability perspective. A mechanical takeoff will be necessary, and possibly resizing of the ducts. The acoustical and mechanical implications will be addressed to ensure that the quality of air and noise level in the gym is improved.

### Analysis 4: Use of Natural Light to Reduce Energy Consumption

#### *Lighting/Electrical Breadth*

The final environmental factor addressed above is covered in analysis four. This topic will determine ways to use the natural light (already provided by large windows) to reduce energy consumption, save the owner money, and improve the space for students and teachers. By adding automatic switches and daylight photosensors that trigger dimming ballasts, the natural light can be used to illuminate the classrooms. Natural light will only save on energy costs when the lights are off or dimmed. Adding the dimming ballasts will have a significant cost and construction impact, and will need to be sized for the appropriate lamps and electrical loads. The electrical complexity of installation will also increase.

## A. Introduction

The Washington Christian Academy (WCA) Flagship and Gymnasium Buildings are part of a phased construction project located in Olney, MD; Montgomery County. These two initial buildings will serve as the base for a growing religious education campus. The owner of the project is a Christian Educational Organization known as the Washington Christian Academy. Their intention is to build a Washington Christian Academy campus that will educate students academically and spiritually. The new Flagship school will provide education for approximately 300 K-12 students and serve as a home to the WCA administration offices. The owner is concerned with cost constraints on the project, but ensuring that the job is done well and that the building is of high quality is more important. The owner put some contingency money in the project budget to allow for changes and additions, but would most like to use the money for last minute upgrades that would really make the educational facility first class.

Since high quality is a priority to the owner, I began looking into ways to increase the quality of schools. This project is not taking any dramatic steps as far as sustainability is concerned, even though it has been proven that students perform better in cleaner, sustainable environments. According to the Pennsylvania Governor's Green Government Council, the three main environmental factors that affect students' performance are: improved indoor air quality, utilization of natural light, and better acoustics. Schools that implement these features are healthier, more cost efficient, sustainable, and the students are more productive. Research has proven that as a result student test scores increase, attendance rates are higher, and the students and staff are healthier. Additionally, the energy consumption of the building generally decreases which saves the owner money every month from the electrical savings. It was based on these findings that the technical analyses were inspired. The analyses will look specifically at the mechanical, acoustics, and lighting/electrical elements of the building. By analyzing these three elements, the three environmental factors listed above are addressed.

The Partnership for Achieving Construction Excellence (PACE) roundtable event inspired the construction industry research issue. I have long been a supporter of becoming bilingual, and this skill would be a great benefit in the construction industry. This event motivated me to look more closely at the English-Spanish language barrier in the construction industry, and what problems are created from this barrier. With schedules as strict as they are today, it is necessary that all involved parties on a project act as a team. Having a language barrier only complicates this process, and ultimately delays the project completion or success.

## B. Analysis 1 – Consequences of the English-Spanish Language Barrier at the Jobsite

### *Critical Industry Issue*

#### **B.1 Problem Statement**

The English-Spanish language barrier between general contractors, subcontractors, and laborers in the Washington, DC and surrounding areas creates problems with efficiency, safety, and a general level of respect. Information is needed to determine which consequences are the most common, and how these consequences affect the success of projects.

#### **B.2 Goal**

The goal of this analysis is to identify the five leading problems the language barrier creates in the industry. The research will focus on the issues presented in the problem statement, and any others that may be prevalent in the industry. Viable solutions will be explored in order to remedy these frequent issues.

#### **B.3 Research Steps**

The following research steps will be taken to conduct, process, interpret, and form conclusions.

1. In order to provide a sound basis, step one is to research the history of the language barrier in the Washington, DC construction industry by reading articles and literature focused on this topic.
2. Speak with my summer project manager and superintendent and gain their perspectives on the status of the barrier in the industry. Ask them what questions would be good to ask industry members regarding language barrier consequences on the jobsite.
3. Make a questionnaire for industry members; specifically project managers and superintendents that have been in the industry for at least five years.
4. Interview or survey 10-15 industry members from the Washington, DC area.
5. Compile responses, identify the top five problems related to the language barrier, and graphically represent the data.
6. Form conclusions and make recommendations on what the industry can do to improve the language differences.

#### **B.4 Expected Outcome**

I expect that the interviews and surveys will yield the top five problems relating to the English-Spanish language barrier on the jobsite. I suspect that three of the top five are listed in the problem statement. This research will also show ways to break down this barrier and remedy the most frequent problems.

**B.5 Summary**

This analysis will enhance my knowledge of a critical industry issue that currently faces the projects in the Washington, DC area. I expect to gain an understanding of the issue, and discover how much it actually affects the success of a project. I am interested in hearing industry member's opinions on the subject, and discover ways that they try to overcome this obstacle. It will be interesting to see whether this problem is slowly going away or if it is progressively getting worse. It is an issue that cannot be ignored; and the only way to solve the problem is to identify the leading consequences and make the necessary changes to move past them.

## C. Analysis 2 – Improve Indoor Air Quality

### *Mechanical Breadth*

#### **C.1 Problem Statement**

The current mechanical system lacks any advanced filtration, which would help create a better indoor air quality for the students and teachers. Adding a mechanical filtration system will help achieve the beneficial environment and possibly save energy.

#### **C.2 Goal**

The analysis will focus on improving the indoor air quality by adding filters to the mechanical system. This option will be addressed for lifetime cost savings, effects on the mechanical units, and the improvement of the indoor air quality. The goal is to improve the quality of air with minimal first costs to the owner, and determine if the life time costs are worthwhile.

#### **C.3 Research Steps**

The following research steps will be taken to conduct, process, interpret, and form conclusions.

1. Research different air filtration methods used in other schools.
2. Address lifecycle costs and air quality improvement.
3. Determine if the filter helps or hurts the mechanical units.
4. Determine how much power the system will demand and reference the drawings/specs to make sure the current system is capable of the loads.
5. Determine the installation and schedule impacts of installing a filtration system.
6. Contact Southland Industries to see if the filtration systems can be prefabricated, and determine the constructability of such a system.
7. Address maintenance and replacement issues.
8. Recommend whether installing an air filtration system is a logical solution for the WCA.

#### **C.4 Expected Outcome**

I expect that an air filter will increase the indoor air quality but that the financial costs may outweigh the measurable benefits. However, instinctually I feel that the filter will help the mechanical units last longer and run more efficiently. Therefore, lifecycle costs may be enough to recommend the system even if it has a high initial cost. This research will also address the construction impacts of adding the filter to the system. There may be requirements on keeping the filters clean during installation, or perhaps prefabrication is an option.

#### **C.5 Summary**

This analysis will specifically address value engineering concepts. The owner will need to be convinced of the benefits of using the added filters. Marketing these upgrades to the owner will be addressed. Furthermore, the interior sequencing and subsequent schedule impacts will be analyzed. It will be

significant to discover which, if any, air filters are being used in schools and the success of the using them, both from a mechanical perspective and student health perspective.



## D. Analysis 3 – Better Acoustics

### *Mechanical/Acoustical Breadth*

#### **D.1 Problem Statement**

The current ductwork in the gymnasium is sheet metal with insulation. This creates a noisy environment, which is certainly not cohesive for a learning/coaching environment. Fabric ductwork will be installed in place of the sheet metal ductwork to better the acoustics and possibly reduce costs.

#### **D.2 Goal**

The analysis will focus on bettering the acoustics by replacing the typical sheet metal ductwork with a fabric duct system. The benefits of using the new ductwork will be researched, such as the reduction of noise in the gymnasium, cost savings, cleanliness, and installation and schedule impacts.

#### **D.3 Research Steps**

The following research steps will be taken to conduct, process, interpret, and form conclusions.

1. Perform a mechanical ductwork quantity takeoff of the gymnasium in order to establish the current amount of sheet metal ductwork.
2. Research fabric ductwork (benefits, costs, installation options, sizes).
3. Resize (if needed) any of the mechanical ductwork to accommodate the new ducts.
4. Contact Southland Industries and ask about fabric duct (availability, maintenance, etc).
5. Determine the acoustical benefits of using fabric ductwork by speaking with Professor Ling and researching on the internet.
6. Address lifecycle costs and schedule impacts (procurement, site storage, installation).
7. Investigate interior sequencing and the possibility of acceleration.
8. Recommend whether the fabric duct replacement is a logical solution for the WCA.

#### **D.4 Expected Outcome**

I expect that the fabric ductwork will cost equal or less money than the sheet metal, and that it will provide the same amount of air to a space while being cheaper and quieter. The interior sequencing may be able to be re-worked. This sequencing may accelerate the schedule if the new ductwork is easier to install or because two crews can work on ductwork (one on sheet metal in the Flagship Building, one on fabric in the Gymnasium). The procurement of materials and availability will determine the overall schedule impacts.

#### **D.5 Summary**

This analysis will also specifically address value engineering concepts. This may also result in cost savings to the owner. It will be interesting to find out how frequently these ducts are used. If they are more cost and acoustically efficient, I will wonder why they are not used more frequently. Convincing

the owner of this upgrade will be based on acoustics, cost savings, constructability with the possibilities of prefabrication, and schedule information.

## E. Analysis 4 – Use of Natural Lighting to Reduce Energy Consumption

### *Lighting/Electrical Breadth*

#### **E.1 Problem Statement**

The third environmental aspect that helps students perform better is having a substantial amount of natural light in the classrooms. There are large windows in every classroom of the school; however this natural light will not result in any energy savings as long as the lights are still turned on. Therefore, adding motion activated switches and daylighting photosensors that trigger dimmers in the classrooms will allow the natural light to benefit students as well as reduce the electricity consumption.

#### **E.2 Goal**

The goal is to address the benefits of adding natural light to the classrooms because this will be the one of the selling points to the owner. The biggest benefit to the owner, however, will be the findings of the research that focuses on energy savings. The addition of motion activated switches with auto-off and manual-on capabilities and daylight photosensors with dimming ballasts will reduce the electricity used each month. By triggering the lights to dim based on the amount of natural light, energy consumption should go way down on a typical daily basis and result in large savings. The cost impacts and energy savings will be addressed, as well as any electrical impacts this may cause.

#### **E.3 Research Steps**

The following research steps will be taken to conduct, process, interpret, and form conclusions.

1. Research sensors used in other schools, like the ones used at The Pennsylvania State University.
2. Contact manufacturers of these products to gain information on cost, electrical impacts, maintenance, lifecycles, reliability, etc.
3. Determine if this affects the interior sequencing and level of complexity for installation.
4. Determine how much energy is saved by using the dimming features, from a financial standpoint.
5. Determine how much extra cost will be associated with purchasing dimming ballasts for the lamps.
6. Compare the results from steps 4 & 5.
7. Recommend whether adding sensor switches and photosensors are worthwhile from a cost standpoint and light quality standpoint.

#### **E.4 Expected Outcome**

This research will yield the benefits of using natural light to illuminate the classrooms. I expect to determine if the sensors are a worthwhile cost investment and whether the pros outweigh the cons of installing the sensors and ballasts.

**E.5 Summary**

A reduction of the energy consumption is beneficial to multiple people, on multiple levels. It helps the students, teachers, owners, and even the global community. In order to do this, using natural light is necessary. The only way, however, this natural light will be worthwhile is if the lights are used less as a result. I am interested to see whether the initial and lifecycle costs account for a true savings. Also, the increased electrical impacts will be interesting. Sizing and figuring out the needed electrical ballasts will be challenging. I also intend to determine the schedule impacts of installing a more complex system. These value engineering ideas will also have to be marketed to the owner. It will be sold on its benefits to the students and staff and monthly electrical savings, not on its initial costs. Constructability reviews will be incorporated to determine if installing this system is feasible, and what electrical impacts it will have on the panel boards and electrical loads.

**F. Weight Matrix**

The weight matrix below breaks down how my time will be spent researching and analyzing each of the topics described above.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
English-Spanish Language Barrier	20%				20%
Improve Indoor Air Quality	5%	10%	5%	10%	30%
Better Acoustics	5%	5%	10%	10%	30%
Use Natural Lighting to Reduce Energy	5%	5%	5%	5%	20%
<b>Total</b>	35%	20%	20%	25%	100%

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