# Technical Assignment 3

## Alternative Methods and Research

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## Executive Summary

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. This technical report identifies issues both in the construction industry and on the WCA project that will serve as the basis for my thesis research in the 2008 spring semester. These issues will be analyzed through research, value engineering analyses, constructability reviews, and schedule reduction analyses.

The Partnership for Achieving Construction Excellence (PACE) Roundtable event covered many leading industry issues that face professionals today. The three topics addressed at the event were prefabrication, building information modeling, and workforce development. The last topic sparked a discussion that had to deal with the rising amount of Hispanic workers in the construction industry. The critical industry issue I will research for thesis is the English-Spanish language barrier that currently exists on many project sites in the Washington, DC area. The consequences of this barrier are far outreaching, and do not seem to be fixing themselves. Therefore, my research will address how prevalent this barrier truly is, and what (if anything) is being done to change it. An example survey is shown in section B, explaining how the information will be gathered.

Technical reports 1 and 2 served as a means to familiarize myself with the WCA project, and discover areas that could be improved. The first technical issue that will be analyzed is replacing the façade with prefabricated precast brick panels. This substitution will shorten the project schedule and free up space around the buildings from scaffolding. The analysis of this topic will focus on the structural changes, schedule, cost, constructability, availability of materials, and crane usage. The second technical issue is increasing the air quality in the buildings through the redesign of the mechanical HVAC systems, particularly changing the sheet metal duct work to fabric duct and adding an air purification system. With health problems rising in schools, having a safe, clean environment needs to be a number one priority. Also, students perform better when they are in a clean, well ventilated area. This analysis will include value engineering solutions, constructability, HVAC system design components, cost, and constructability.

# A. Critical Industry Issues

### A.1 Overview

The 16th Annual Partnership for Achieving Construction Excellence (PACE) Roundtable was held at Penn State on October 23rd and 24th, 2007. The purpose of the Roundtable event is to provide an opportunity for industry members and Penn State AE faculty and students to interact. The focus of the discussions is meant to address problems the construction industry currently faces, and to share or brainstorm viable solutions. The event also provides great networking opportunities for fifth year AE seniors. Many of the issues addressed are applicable to the senior thesis projects.

### A.2 Topic I: Prefabrication

Four panel members discussed problems that they observed with prefabrication in the current construction industry. The main problems were summarized to be transportation limitations, code requirements, cost worthiness, and design restrictions. Furthermore, it was agreed upon that the term prefabrication carries of stigma of lesser quality.

Transporting the prefabricated pieces to the site is an issue because the pieces are usually very large and heavy. Also, the pieces need to be delivered in sequential order and on time (ideally). This creates many problems such as truck capacities, road capacities, availability and quantity of trucks, and possibly having to cut larger pieces into smaller ones and designing connections to get them back together. If the building was to be LEED rated, materials must be obtained from a radius of 500 miles. This puts a limitation on where the fabricating plant or warehouse may be located. Gas and toll costs should also be considered.

Code and cost worthiness were not discussed in as much detail as the other problems. However, some localities have codes that do not allow prefabrication. This may be to help the local workforce in the construction industry. It may also be because of the poor connotation prefabrication brings to a project. Cost worthiness would have to be addressed on a project by project basis. Obviously prefabrication would not be recommended on a very complex, architecturally unique building. However, some rather unique buildings could still employ prefabrication on certain systems or aspects of the building. Not all parts of the building need to employ prefabricated pieces. The cost of constructing these units may go down, but the transportation and design changes may overshadow the savings.

The design restrictions are not ideal for an architect. It is typically found that architects are against prefabrication because prefabrication is synonymous with bland, repetitious buildings. This is not necessarily true. It is true, however, that design changes are much more costly once prefabrication has begun; and that production is very early on in the project timeline. Architects and owners need to be convinced early on that prefabrication is a viable solution for their building. Especially in design-build projects and LEED projects, prefabrication may help save money. There is a very good chance that prefabrication will result in less wasted material, that the indoor air quality will be improved because the systems are cleaner, and that the systems will operate like they were designed to operate (essentially perfect).

The prefabrication discussion greatly interested me. I was surprised to hear how a "smart wall" works. Essentially, it is a prefabricated wall with the rough-ins, raceways, cabinetry, and connections already in place. As far as I know, this is an extreme case of prefabrication. It was interesting to see where prefabrication may go in the next few years. This may be applicable to my building considering that it is a school building. Many of the classrooms have repeatable parts. Also, the entire exterior is a brick façade. I am curious if using prefabricated precast brick paneling would be more cost efficient and save time. I made a contact with Ted Border from Whiting Turner. Ted actually spoke in our AE 473 class about a very successful prefabrication project.

**A.3 Topic II: Building Information Modeling (BIM)**

This panel also consisted of four panel members. However, this panel was more focused on discussion from the audience. Initially, a list of advantages and disadvantages to using BIM in the industry were addressed. The advantages were as follows: BIM cuts down on waste (paper, exchange of drawings & information, and time); helps communication between parties; allows for digital fabrication; and is more efficient (clash detection, missed scope, and time). The disadvantages were as follows: implementation in a traditional industry; standards across the industry; measuring the benefits quantitatively; and subcontractor's capabilities of making/interpreting building information models.

The two most talked about items of those listed above seem to be the implementation and the need for standardization. The first question raised was how a company convinces an owner that a BIM is worthwhile, especially if that owner is an experienced owner with the traditional construction methods. Additionally, many of the first few projects BIM is used on typically have problems to work out and can lose money (or at least cost more than they would have traditionally). A few companies at the Roundtable have pushed BIM in their companies, and gave some advice. But honestly, it seems that there really is no exact solution on how to convince an owner. Without quantifiable data (which also seems very difficult to produce), it is hard to have a sure-fire way of convincing an owner.

BIM standards are necessary throughout the industry because subcontractors work on multiple projects simultaneously with different contractors, owners, and architects. It is too much to expect drawings to be shared by trades and design professionals that do not have a standard set of conventions. If the subcontractors are not able to contribute and/or interpret BIMs, they will have to subcontract the modeling to a company that specializes in modeling or hire a modeler. This creates an entire new valuable position in the construction industry.

Barton Malow had a lot of input as far as implementing initial BIM projects in a company. Jacobs Engineering and Skanska are companies that are also spear heading the BIM integration in the industry. Todd Vochinsky and Bob Grottenthaler from Barton Malow are valuable contacts for how to integrate BIMs into a company that is not very familiar with this modeling technique. I am not sure that building information models are the most effective tool for the Washington Christian Academy considering that it is not very large or complex. However, there are obvious benefits from using BIMs no matter what size or complexity the project is.

**A.4 Topic III: Workforce Development**

The four panel members addressed the workforce shortages particularly in the Washington, DC area. The main issues addressed were the negative perception of construction workers, immigration and the political environment, and making responsible schedules. Somewhere along the line, manually laborious careers assumed a negative connotation. Students are encouraged to go to college so that they can avoid working manually outside, even if it results in a lower paying job. This is a result of parents and high school guidance counselors. The stigma that construction work is only for immigrants and high school dropouts came about because parents want their children to have safe, reliable, well paying jobs. Back when parents of high school students worked and their parents worked, construction work was a lot more dangerous and had an unsteady work flow. This is not necessarily true anymore. It was stated that school guidance counselors who know that a student will not excel in college will not recommend construction work because of the ramifications from complaining parents.

The political environment, and particularly the elections of 2008, will play a large role in affecting the labor force in the Washington, DC area. Immigration laws are a hot topic in politics right now. Currently, a substantial amount of workers are of Hispanic ethnicity. Immigration restrictions could hinder workers from coming into the country. A very interesting story was told at the Roundtable event. Many of the immigrant workers are not trained construction workers; however it is the one of the only jobs they can get once they are in the United States. On one discussed project, the management sought to help the immigrant workers find careers that were suited to their talents. Also, there are communication barriers between project management and construction workers.

Lastly, schedules need to be made responsibly on both the part of the owner and contractor. Faster, more difficult schedules require more laborers and ideally more skilled laborers. Grueling schedules make it hard to find qualified subcontractors that can actually perform at that pace. This is not because the workers are incompetent; rather it is that they are working on a multitude of projects that all need to meet strict deadlines. Labor shortages are not an issue on the Washington Christian Academy project, mainly because the project is small-medium size. Also, the building is not that complex. It is outside of Washington, DC (in Olney, MD) and may have a few problems getting qualified subcontractors locally. I met Kara Prince from Bovis Lend Lease and she was interested in my passion for breaking down the language barrier between Spanish speaking workers and English speaking workers and management. She explained that Bovis Lend Lease currently has a class for their employees called Construction Spanish for Managers.

**A.5 Conclusion**

An overall conclusion was drawn at the end of the Roundtable event. It was noted periodically through the day that many of the issues involved owner and architect input. For the future, it may be beneficial to bring in more architects and start inviting owners to the event. It would help all parties to understand each other better and truly start changing the industry, especially if design-build is the wave of the future.

# B. Critical Issues Research Method

**B.1 Overview**

The PACE Roundtable event addressed critical issues that presently face the construction industry. It is my intent to research one of these topics and find ways to begin to overcome this problem. I am interested in the labor development issue and labor related problems that are experienced on project sites daily, particularly in the Washington, DC area. Specifically, I will investigate the English-Spanish language barrier typically between a general contractor and subcontractors. This barrier inhibits work productivity, efficiency, safety, and ultimately respect on a project site.

**B.2 Problem Statement**

The English-Spanish language barrier between general contractors, subcontractors, and laborers in the Washington, DC and surrounding areas creates problems with productivity, efficiency, safety, and a general level of respect.

**B.3 Goals of Research & Benefactors**

It is the goal of my research to:

First, identify the leading problems the language barrier creates in the industry. In the problem statement, four preliminary consequences of the language barrier were stated. I will aim to see if these four are the most prevalent issues, and if not, then what are they?

Second, understand why this language barrier exists. I have primitive thoughts, but factual research will reveal why the language barrier stands as it is today, and how it has become greater/less prevalent over the past few decades.

Third, it is my highest priority to improve jobsite communication between the current general contractors (specifically superintendents), subcontractors, and laborers in the Washington, DC area. Architects, owners, and project managers may indirectly benefit from this research also. I intend to research methods that will help to breakdown this barrier on project sites. This will be a two way process, including the education of both English and Spanish; not merely one language being forced to learn the other.

Last, I would like to research how colleges and construction internships are preparing students for a bilingual industry. More precisely, if nothing is being taught as far as the Spanish-English barriers, why not and what can change?

**B.4 Research Steps**

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

1. Research the history of the language barrier in the Washington, DC construction industry.

2. Investigate what the leading consequences of this barrier are and what companies are doing in the DC area to combat this problem through interviews and surveys, including superintendents and project managers of general contractors, foreman and project managers of subcontractors, and architects.
3. Investigate what schools and construction internships are doing to combat this problem through interviews and surveys, including universities with construction programs, general contractors, and subcontractors with internship programs.
4. Compile data and graphically represent information.
5. Form conclusions and make recommendations on what the industry can do to improve the language differences.
6. Make an implementation plan for the effected parties, and clearly define the benefits of instituting such a plan.

**B.5 Sources of Information**

The following outside sources of information are needed to complete the research steps outlined above:

1. Historical information on the construction workforce in the Washington, DC area.
2. Relatively current construction magazine articles, newspaper articles, and other published works containing information and statistics on this issue from the Penn State Library Access Database.
3. Industry members for surveying and interviews.
4. University faculty.

**B.6 Example Survey**

An example survey for industry members is shown on the following page. Please note that parts of this survey will be written in Spanish, and that it is likely to be changed and edited before being sent. This is merely an example, and it will be fine tuned with the help of feedback from my piers review.

# C. Problem Identification

**C.1 Overview**

Construction projects are bound to face technical problems that range from preconstruction to substantial completion, and often times beyond. The purpose of the Washington Christian Academy is to educate students in the best possible learning environment. It is well known that education continues well beyond childhood school days. In an effort to continue the learning process and foster a productive learning atmosphere for all parties involved on the project, education will become the theme of the research and problem areas of the Washington Christian Academy project. The critical research issue outlined in section B is all about growth and betterment through linguistic education. The technical problems addressed in sections C and D will be about making the actual education facility the best possible learning atmosphere for the students.

**C.2 Problematic Features**

There are several problematic features of the Washington Christian Academy project that can be analyzed and hopefully resolved through research and technical analysis.

A. Early schedule delays due to permitting have made the substantial completion date much later than intended. The project must be completed by the 2008-2009 school year (August). The schedule must be accelerated.
B. The crane sequencing seems to move the crane around the site and back and forth between the two buildings too much. This creates conflicts with the masons and scaffolding for the exterior of the building.
C. The Flagship Building and Gymnasium have large, open spaces that require a lot of ventilation and large HVAC equipment. This is both costly and noisy. Additionally, it takes more time to install.
D. The structural system and exterior facades of both buildings rely on masons (for CMU block and brick facades). This system is taking a substantially long time to complete.
E. Typical HVAC and lighting systems have been used in the school, even though it has been proven that students perform better with above standard HVAC and lighting systems.

# D. Technical Analysis Methods

**D.1 Technical Analysis 1: Use Precast Brick Panels instead of Hand-Laid Brick**

- Standard brick installation requires large amounts of scaffolding, which causes site congestion especially for the mobile crane.
- Bricks and mortar need to be stored around the site near each scaffold, which are not easily moved for construction phasing.
- Standard brick installation requires more personnel, which increases safety and coordination issues.
- Typical brick installation takes much more time than precast erection.

Research comparing precast brick panels with standard mason-laid brick installation will primarily focus on schedule acceleration and cost impacts. One of the prerequisites will be that the quality must remain the same or better, unless the schedule acceleration and cost savings are deemed worthy to outweigh the quality difference. Additionally, the structural and architectural differences will be addressed.

Considering that this project is a Design-Build project, many interesting features of the prefabrication process will be researched. The early input from contractors and subcontractors will help to ease the difficulties with designing precast systems. However, any late changes or design oversights will be very problematic in the prefabrication process. So more specifically, in addition to analyzing whether the prefabricated walls are worthwhile structurally, financially, and time-wise, I will analyze how it is affected in the Design-Build process.

I intend to research prefabricated wall systems and compare by cost, schedule, constructability, availability, and site utilization. I will speak with industry professionals for their opinions and knowledge of the subject.

**D.2 Technical Analysis 2: Using Fabric Ductwork and Air Purification Systems for the HVAC Systems**

- School students are proven to excel in healthier environments. With the current MRSA scare in schools on the east coast, enough is not being done as far as air purification and clean HVAC systems are concerned.
- Large spaces, such as the gymnasium and cafeteria, will be redesigned with fabric ductwork to reduce noise and increase sterilization.
- Air purification elements (yet to be researched) will be added to both buildings' entire HVAC Systems.
- The storefront windows in the Flagship and Gymnasium are inoperable, so the need for cleaner, filtered air is a worthwhile cause.

Students spend an overwhelming amount of time in their school building. While hospital-level sanitation is not necessary, more than the current school standard is needed. The Washington Christian Academy owner's primary concern is creating a healthy, productive learning environment for their students that will last a long time. By making changes to the current HVAC system, the students will be

healthier, will perform better, and the school will sustain longer. I plan to compare the two HVAC systems, and redesign the system with the new ductwork and air purifies. Quality will be the first most concern, followed by cost (initial and life cycle), availability, and constructability. Schedule impacts will also be addressed, as any extra time needed to install or order the system will have a great effect on whether or not it is practical to use.

## E. 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** | 35% | | | | 35% |
| **Precast Brick Facade** | 5% | 5% | 10% | 10% | 30% |
| **Redesign HVAC System for Air Quality Purposes** | 5% | 15% | 15% | | 35% |
| **Total** | 45% | 20% | 20% | 15% | 100% |