

Technical Analysis 3

Alternative Methods and Research



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Executive Summary

This technical report, *Alternative Methods and Research*, is the foundation of the research topics for next semester. Several topics have been investigated and analyzed on how they could apply to Pasadena Elementary School.

The first section of the report discusses Critical Industry Issues. Three issues were brought up at the Pace Roundtable in October in a panel format including Prefabrication, Building Information Modeling and Labor Management. The main questions and concerns that were discussed for each issue are listed.

In the section Critical Issues Research Method, the research topic of LEED Rating is discussed. Pasadena Elementary School did not strive to become LEED Certified. Using LEED for Schools as a guide, prerequisites and credits for LEED points will be sought after to achieve a minimum of LEED Certified.

Several industry topics relating to sustainability are listed in the Problem Identification section. These topics were briefly researched to see the practicality of how they would apply to Pasadena Elementary school. These topics include: Greenroofs, Underfloor Air Distribution Systems, Chilled Beams, Water Efficient Plumbing Fixtures, Daylight and Views Analysis and Cooling Towers versus Ice Coolers.

Finally from the list above three analyses were chosen that research will be conducted on next semester. They include: Greenroofs, Underfloor Air Distribution Systems, and Chilled Beams.

At the end of this report is a weight matrix on how the research topics are distributed. Each topic is weighted from 10-40% of the final thesis research.

Critical Industry Issues

The Pace Roundtable was held in October and was attended by industry professionals, Penn State AE Faculty and students. The theme for this year was “Building Collaboration” and the following topics were discussed: Prefabrication, Building Information Modeling and Workforce Development. Each topic was discussed in a panel format with experienced industry members in each topic discussing and responding to questions and comments that were posed by all in attendance. At the conclusion of the day students left with ideas that they could concentrate on while performing their thesis research. Everyone in attendance will meet again in April and students will present the conclusions they came up with when researching these industry topics.

Topic 1: Prefabrication

Prefabrication can accelerate the schedule of a project and can make the project cheaper when planned properly at the beginning of the design. Many ideas were shared on the issue and are summarized below:

- Residential versus Commercial prefabrication was discussed
 - Residential can include anything up to and including entire houses being built off-site and delivered to the property location
 - Commercial includes parts of buildings including exterior facades, beams and other structural members and considerable pieces of equipment
- A hindering factor in commercial prefabrication include issues such as building codes and transportation
- Prefabrication is executed the best when it is planned from the beginning of the project
- A need for a prefabrication mindset is needed at the beginning of projects because only then will we reap the benefits including schedule acceleration and possible savings
- Prefabrication usually, but not all the time, works best on design-build projects
- A concern arose that if there was more work on the design end of a project due to prefabrication, should design professionals be paid more?
- Coordination with other trades is essential both on-site and off-site
- Buildings seeking LEED Ratings could earn credits due to minimizing waste and also because systems usually run more effectively according to their design when prefabricated
- It was discussed who would take charge and control prefabrication initiatives in the industry and this is something the industry needs to address
- Quality is usually better with prefabrication because it is performed in a controlled environment

Topic 2: Building Information Modeling (BIM)

Building Information Modeling was introduced to the industry about a decade ago and is now taking off. However there are still several issues with this topic which are imperative that the industry works them out. Below is a summary of what was discussed at the roundtable:

- One of the main benefits to BIM is that it improves communication between construction trades, designers and owners
- It can greatly help fabrication of systems
- Research needs to be performed on cost benefits and delivery methods due to Building Information Modeling
- BIM is such a great expense that most subcontractors, especially those of smaller nature will not pay for its use which causes a large problem
- Why should the subcontractors pay for BIM since it deals with design issues?
- Benefits need to be compared to initial costs. For example, there is a significant reduction in Requests for Information (RFIs) so how much cost does this actually save?
- Equal standards have not been set across the industry but how could they be reached?
- There will always be issues with people controlling information such as the files, logistic issues, etc.
- How can the design and construction processes be changed to take advantage of BIM?
- Integration should be done on the construction site so it is known how to incorporate changes in the design
- There is a heavy pressure on the owners to pay large expenses due to software standards
- Also it is the owner's responsibility to initiate the use of BIM on a project

Topic 3: Workforce Development

There is a critical issue arising in the industry which contractors are having trouble recruiting and retaining employees. This is due to a few factors and several of them were discussed at the roundtable:

- The construction industry is currently not an attractive career to a potential worker
- The industry has a negative image. For example parents would not tell their sons or daughters that they should go into the construction industry as they grow up.

- All of the opportunities and benefits that the industry has to offer are not widely known amongst people
- The industry should work on changing its image to the public so people will want to work for construction companies
- Children should be taught growing up about the positive things the industry has to offer so they will not hold a negative connotation of construction
- High school plans and internships are an excellent way to recruit young men and women into the industry
- Immigration issues have risen but next year's presidential election will be a major deciding factor on the future for immigration
- For current employees it is important to assess their skills and put them on a career path they will be successful on so they will want to stay in the construction industry

Critical Issues Research Method

Problem Statement

An analysis will be performed to achieve a minimum of a LEED Certified Rating for Pasadena Elementary School. A LEED Rating was not sought after at the time of design or construction. Minimal initial costs are ideal, but lower lifetime energy and cost savings are of utmost importance.

Research Goals

School boards and districts are hesitant to support the construction of a green and sustainable building. It is thought that there is a large increase in initial costs of the building. The goal of this research is to demonstrate that low initial costs are all that is needed and that there will still be a significant savings in lifetime operating and maintenance costs. This will be done by investigating the obstacles on both the owner and designer's side of the industry.

Research Steps

1. Generate a group of questions to ask public school district officials about the reasons they do not initiate green building design in their school district.
2. Generate a group of questions to ask designers who specialize in school buildings about how designing green buildings would have an effect on their design.
3. Interview industry professionals—both owners and designers.
4. Compare the desires of the owners to that of the architects and designers to find common features of the building that can aide in LEED Certification.

5. Create a list of LEED Prerequisites and Credits that can be met based on the wants of the owners and designers that will achieve a minimum of a LEED Certification Rating.
6. Calculate the total amounts of points earned by adding the credits that were met.

Data Collection Draft

Interview questions to be asked to public school district officials:

- State your name, position in the school district and the name of the school.
- How many students will occupy the new building?
- What type of setting is the school building in (city, rural or suburban)?
- Which is more important to you: initial cost or lifetime cost of the building?
- What are the expected operation and maintenance costs of the building?
- What are some things that you would like to see change from the existing school that will be replaced?
- What features do you feel are absolutely imperative to the building and cannot be removed from the design?
- Do you have any hesitation and if so what is the largest when someone mentions the idea of constructing a green school?
- Do you have any intention of using a green building for student interaction in learning?

Interview questions to be asked to public school district officials:

- State your name, name of firm, job title and the name of the school.
- Are you a LEED Accredited Professional?
- Have you ever worked on a building that achieved a LEED rating?
- If so, what role did you play in the project?
- Does your firm take an interest in LEED projects?
- What are some things you would like to see changed from the existing school that will be replaced?
- What features do you feel are absolutely imperative to the building and cannot be removed from the design?
- Do you have any hesitation and if so what is the largest when someone mentions the idea of a green school?
- What barriers are there with green design?

Problem Identification

Several topics that are linked to sustainability are listed below. These issues can be studied through the analysis of building systems and construction methods. They could each potentially apply to value engineering, apply a positive effect to the constructability of the building and also cause a reduction in the schedule.

- Achieve a minimum of a **LEED Certified Rating** by using the reference LEED for Schools
- Design a **greenroof** in lieu of the conventional roof that is in the school's original design
- Design and analyze an **Underfloor Air Distribution** system as an alternative for the designed HVAC system
- Study **chilled beams** and how they can effectively make the school more efficient and reduce operating costs
- Investigate **water efficient plumbing fixtures** and how they would reduce the amount of potable water that is used in the school
- Perform a **daylight and views analysis** and try to increase each in the classroom spaces
- Compare **Ice Storage Systems and Cooling Towers** and determine which is better due to efficiency, schedule impact and construction and operating costs

Technical Analysis Methods

To assist in LEED Certification several features of the building will be looked at including the topics below. Each of these analyses will assist in several credits in different categories in the rating process.

Analysis 1: Greenroof Design

A greenroof on an elementary school can aid in stormwater control and reduce the amount of thermal heat that is absorbed by the building. Pasadena Elementary School has a conventional roof in its original design. By implementing a greenroof a possibility of 6-16 credits could be gained for a LEED rating.

The following is a list of steps that will be performed while studying this topic:

- Research will be performed to obtain information of the different types of greenroofs (Extensive vs. Intensive)
- A type will be determined that is the best suited choice for Pasadena Elementary School
- An effort will be made to take into consideration of how implementing a greenroof will affect other systems and features of the building. These shall include:
 - Structural systems due to an increase in loads
 - Mechanical system will be affected because of an increase in stormwater drainage and a decrease to heat absorbed by the building's roof
 - Architectural features on the facade may be impacted for aesthetic reasons
 - How initial, operation and maintenance costs will be affected
 - How the schedule will be impacted

Analysis 2: Underfloor Air Distribution

Underfloor Air Distribution is an alternative HVAC system that could be used in lieu of traditional systems that are located in the plenum space of the building. Research and an analysis will be performed on this type of system and how it will change the design of Pasadena Elementary School. The system may aide to points in LEED credits for Indoor Air Quality Control which will be evaluated at a later time. The following is a list of steps that will be performed while studying this topic:

- Research will be performed of the different types of Underfloor Air Distribution (UAD) systems (Neutralized Plenum vs. Pressurized Plenum)
- A type will be determined that is the best suited choice for Pasadena Elementary School
- An effort will be made to take into consideration of how implementing a UAD system will affect the building's current design. The following will be taken into consideration:
 - The architecture of the interior of the building will be changed significantly due to a decrease in ceiling plenum space and raised flooring
 - Depending on the type of UAD fewer materials will be needed because not as much supply ductwork will be used
 - Indoor air quality will be affected due to the fact that the uniform temperature of occupied spaces will be at a different location that the previous system (Uniform temperature will be from 3-6 feet above finished floor)
 - How initial, operation and maintenance costs will be affected

- How the schedule will be impacted

Analysis 3: Chilled Beams

An alternative to Underfloor Distribution System is to use chilled beams as the primary HVAC system for the building. This is a new technology to the industry and has a significant impact of energy usage and comfort levels in occupied spaces. The following is a list of steps that will be performed while studying this topic:

- Research will be performed on different types of chilled beams (Active vs. Passive)
- A type will be determined that is the best suited choice for Pasadena Elementary School
- An effort will be made to take into consideration of how implementing a UAD system will affect the building’s current design. The following will be taken into consideration:
 - Comfort levels will be dramatically affected due to the nature of the system and will be analyzed when considering indoor air quality
 - Mechanical system will be downsized due to a need for both energy and fewer air changes
 - Architectural features will change because of smaller plenum space and the aesthetic nature of the beams
 - Construction costs will rise since the technology is new to the industry
 - Life cycle costs will be calculated to see savings, if any
 - How the schedule will be impacted

Note: As stated earlier in the report LEED Certification will be analyzed. This will be done for two different scenarios—one for the Underfloor Air Distribution system and one for a Chilled Beams system.

Weight Matrix

The following is a table that summarizes how work on these four analyses will be distributed throughout thesis work. It shows how much each of the analyses is studied during the project and also the amount that the following topics are addressed: Research, Value Engineering, Constructability Review and Schedule Reduction.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
LEED Rating System	30	0	0	0	30
Green Roof	0	10	10	0	20
Underfloor Air Distribution	0	10	10	5	25
Chilled Beams	0	10	10	5	25
Total	30	30	30	10	100