# Pennsylvania State University Burrowes Building: Proposal

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Courtesy of BLT Architects

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# Executive Summary

The Burrowes Building located on the Pennsylvania State University campus is a renovation project that was selected for use as part of an AE Senior Capstone Thesis. The purpose of the AE Senior Capstone Thesis is to test a Construction Management students' knowledge they've obtained over the past 4 years in the AE program by researching and presenting on a construction project from beginning to end. This Proposal will cover four different analyses of the different building systems and construction methods of the Burrowes Building Renovation. These analyses were developed with the help of the 24th PACE Roundtable, project contacts, and faculty members. For each analysis the problem will be defined with background research performed, potential solutions, and the steps performed to help achieve a successful outcome.

Analysis #1

This analysis will explore the support of excavation of the knuckle structures. Micropiles were driven down to help support the new knuckle structure after the existing ones were demoed down to the footers. Research will be performed to determine if there would be any savings by switching the pile material from steel to timber, concrete or composite piles. Another possible option would be to use a completely different pile or foundation system.

Analysis #2

The second analysis will look at the constructability of the core-building basement. The basement has a ceiling height of six feet and the chosen solution was to excavate down four feet to create ten feet of ceiling height. This would allow for all of the mechanical equipment to be stored in the basement and could allow enough room for the end user to perform maintenance on equipment. There were other methods discussed such as building a structure on the mall side of the core-building to house the mechanical equipment or placing all of the equipment on the roof. This analysis will research these two alternatives to determine if there would be a cost and schedule savings by using one of these methods instead of the one chosen.

Analysis #3

The third analysis of this proposal will address the site logistics of this project to look for possible improvements to site access for safety as well as provide more access for deliveries to make the site more efficient and cut down on schedule time. The site is directly in the center of campus and there is only one road in or out of the site, so this limits deliveries to only one at a time, which is very inefficient.

## Research Topic

The research topic for this proposal is going to analyze two different project teams through a designer's perspective. The Agricultural Engineering Building and the North Halls project on the Penn State campus both have EYP as the designer. Three people from each design team will be interviewed to get feedback on the selection process, team satisfaction, delivery method, and overall experiences for the two different projects. This will help to give an idea of how an integrated project delivery method differs from traditional delivery methods. It will also provide OPP with data they can use to analyze future projects.

# Table of Contents

# Analysis #1 Support of Excavation of Knuckles

**Opportunity Identified**

The knuckles of the Burrowes Building renovation proved to be one of the most difficult aspects of this project. There were many unforeseen issues with bedrock, steel erection, and weather. Steel micropiles were driven down after the existing knuckles structures were demolished to help with underpinning the foundation and support the new structures. It is proposed that using a different pile material or pile system could result in a cost and schedule savings on the project.

**Background Research**

A pile driver can be very expensive and can end up being a long intensive process depending on soil types. Timber, concrete, and composite are all materials that are used for piles. Piles can either be driven or bored down into the soil. This analysis will research what method is cheaper and what material is the best to use. Piles are classified into three different categories: end bearing, friction, and combination.

**Potential Solutions**

One potential solution could result from using a pre-cast concrete pile system instead of steel. This could be achieved by drilling holes to ensure the concrete would not be damaged by driving the piles into the soil. Another possible solution would be to utilize timber piles to dramatically reduce cost per pile and potentially reduce schedule time.

**Analysis Procedure**

1. Feasibility study
    - Choose the most practical option for the pile system.
    - Determine accessibility to timber and pre-cast piles in the area.
2. Research
    - Research why certain pile materials are chosen for different applications.
    - Research methods and processes of installing piles.
    - Research how soils affect pile selection.
    - Research costs associate with each pile method and material.
3. Technical Analysis
    - Calculate costs to install alternative pile system at knuckle structure.
    - Use RS means and other methods to determine costs.
    - Evaluate schedule impact and cost savings if applicable.
    - Perform a **structural breadth analysis** of the pile system used for the knuckles.

4. Recommendations
    - Recommend an alternative method based on the results of the research performed.

**Expected Outcome**

As a result from the analysis it is expected that one of the alternative pile systems will result in a cost and schedule savings for the project from the chosen steel pile system. Using one of the alternative methods such as timber piles or pre-cast piles can increase sustainability practices for a project trying to achieve LEED Silver certification. If none of the alternatives prove to be more feasible than the original system that will be noted accordingly.

## Analysis #2 Constructability of Basement

**Opportunity Identified**

There was much discussion between the project manager and Penn State about the status of the basement. The original ceiling height of the basement was 6 feet. This made the basement a dead space because there wasn't enough room to turn it into a mechanical room. The proposed and implemented method was to excavate down 4 more feet and pour new footers to allow for sufficient head space so a mechanical room could be created. This turned out to be very expensive and there were other alternatives mentioned, but never pursued.

**Background Research**

Excavation can be very expensive when compared to building up. This is why skyscrapers were developed because there was a lot of bedrock in areas like New York City so it was cheaper to build toward the sky to obtain desired square footage than down into the earth. The Pennsylvania State University has many historic building on campus with a lot of rich history behind them. This creates a lot of difficulties when trying to change the exterior look of the buildings. This is one of the major reasons that the project team decided to excavate the basement down four extra feet instead of adding on an extra structure to house the mechanical equipment or place the units on the roof.

**Potential Solutions**

One of the potential solutions to this analysis would be to create a new structure to house the mechanical equipment on the mall side of the building underneath the entrance. This solution would provide potential schedule savings because rock excavation would not be required like it was in the basement. It also would provide easier access to service the equipment. Eliminating all the major deep excavation would also provide a cost savings to the project. The other

proposed solution would require putting the units on the roof of the building which would require no excavation. This solution however will require a calculation of the roofing system to determine if the current system can support the increased load or if a new roofing system would need to be designed to support it. This solution has the potential to significantly decrease project costs and schedule time if the roof does not need to be redesigned.

**Analysis Procedure**

1. Feasibility Study
    - Determine if PSU would approve the proposed methods.
2. Research
    - Research existing roof structure and load requirements.
    - Research rooftop Air Handling Units.
3. Technical Analysis
    - Perform square foot estimate on new structure using RS Means.
    - Perform load calculations for roof to determine structural integrity.
    - Determine unit size of AHU required to supply building and fit into new locations.
    - Perform a **mechanical breadth analysis** of the air handling units chosen to determine if they can be resized to be more efficient.
4. Recommendations
    - Recommend the best possible solution to offer the most cost and schedule savings for the project.

**Expected Outcome**

It is expected from analyzing the two solutions described above that one or both solutions will result in savings in both cost and time for the project when compared to the chosen method of excavating the basement, to house the mechanical equipment. These two methods will need to be approved by Penn State in order for the chosen solutions to be implemented into the project.

## Analysis #3 Site Logistics

**Opportunity Identified**

The Burrowes Building is situated in the center of the Pennsylvania University Campus. This created a site logistics nightmare for the project manager. There is only one access road in and out of the site and deliveries were only allowed to occur before 7am to ensure student safety.

There are some potential opportunities to add another access road on the mall side of the building near the library or creating another entrance off of Pollock road.

**Background Research**

There are many different safety measures when it comes to site logistics. A construction project on one of the largest universities in the country is going to have a lot of student foot traffic on the perimeter of the site. This means that there is going to be extra safety precautions that should be implemented that wouldn't be on a typical office building in a rural area. The Burrowes Building site has very little room for material laydown and has heritage trees scattered throughout the site. These heritage trees are trees that are protected and cannot be damaged or destroyed. Separate fencing is to be placed around these trees to ensure equipment does not run into them or have material stored on the roots.

**Potential Solutions**

A potential solution to this problem would be to shut off one side of the mall near the library and provide another access road for construction traffic to come in and out of the site. The site as it is now is very inefficient and only one vehicle can come in or out at a time. This creates a waste of time waiting around that could be used for completing tasks on the project. If another road was created into the site this would create a better flow of traffic and cut down travel time for construction activities. It would also allow a better opportunity for eighteen wheelers to bring deliveries on site. The current road does not allow enough room for a large truck to maneuver into the site. A second solution could be to phase the project into three different sections starting on the north side by the library. This would allow the project to have more material laydown and would make the site a safer and less congested site as compared to constructing the whole project simultaneously.

**Analysis Procedure**

1. Research
    - Research site logistics safety measures.
    - Research site efficiency.
    - Research lean methods to implement into site logistics.
    - Research site phasing.
2. Technical Analysis
    - Create a site logistics plan using methods researched above.
3. Recommendations
    - Recommend the best possible site logistics plan to use to maximize the Burrowes Building project site.

**Expected Outcome**

It is expected that the solutions above will provide the Burrowes Building Renovation project with a more efficient and safe site while not sacrificing the schedule or budget. Opening up another access road into site will potentially decrease overall schedule time and will allow less time for deliveries on site. These solutions will also potentially increase the safety of students walking in and around the site on a daily basis.

## Research Topic Delivery Methods Comparison

At the 24th Annual PACE Roundtable there were many different potential research ideas developed with industry leaders. One of the issues discussed was the fact that there has never been an Integrated Project Delivery project on campus and the Office of Physical Plant (OPP) wants to get a lot of feedback from this project to use for future team selections and delivery methods. The idea that was chosen to be pursued for this proposal is the idea of interviewing EYP the designer of both the Agricultural Engineering building and the North Halls Project on the Pennsylvania State University campus. The interviews will be conducted with three members of EYP from each of the two projects. The process for this research will begin with developing the questions with the help of OPP and DPR. Next the interviews will be setup with each of the members from EYP. The interviews will be conducted and recorded using a recorder. The information will then be processed and a chart will be developed to compare the two different projects. Some of the potential questions to be asked will include: How were you selected for each project?, What was your experience for each process?, What are the main differences between the two projects?, Does one project have any advantages over the other?, What was your selection process?, and an array of other questions that will be developed early next semester. These interviews will provide feedback on the experiences and satisfaction of a designer working on an IPD project and a traditional delivery method project with the same owner. This will also provide OPP data to use for future projects when deciding on a delivery method and provide a standard set of questions they can use to interview future project team members. After the interviews are performed the two different teams will be compared to see if the IPD project has any major advantages over the other delivery method.

## Conclusions

The four analyses described above have the opportunity to improve the quality and satisfaction of the design and construction of the Burrowes Building Renovation. The analyses will be performed using in depth research and calculations throughout the spring semester in order to determine if the potential solutions chosen will be effective. Some of the proposed alternatives may prove to have no beneficial value to the project and that will be noted as the spring semester goes on. One analysis will also look into a critical industry issue developed from the

24th PACE Roundtable and research that topic. All of these analyses will be well documented throughout the year. This will lead up to the final report and thesis presentation that will occur in April.

# APPENDIX A:

# Breadth Studies

**Breadth Opportunities**

Overview

Part of the Senior Capstone Thesis requires students to demonstrate knowledge of other disciplines with breadth studies. Within the four analyses to be executed above there are opportunities for breadths to be performed in two different disciplines of Architectural Engineering. The breadths for this proposal will be a structural and a mechanical breadth.

Structural Breadth

The first proposed breadth topic is to analyze the pile system used for the knuckle structures on the Burrowes Building Renovation. The chosen system for the project was sets of steel micropiles driven into the soil with a pile driver. This breadth will look at alternatives such as timber or concrete piles to determine if there are any cost or schedule savings by switching from steel. There will be calculations performed to determine if the alternative methods compare to the steel piles and determine if drilling or boring the piles will be a cheaper method.

Mechanical Breadth

The second breadth topic will be to analyze the mechanical system and determine if the air handling units in the basement could be resized to create more space in the basement instead of having the six smaller 10,000cfm each unit. The proposed method would be to use two 30,000cfm units or three 20,000cfm units to allow for more service space of the mechanical room. This will also allow for the possibility of more generic units versus the custom ones that were created for this project. This will help to drive down costs and could provide a shorter lead time as far as receiving the units. A cost analysis will be performed for the new system versus the chosen system for the project to determine if there is any feasibility of the new system.