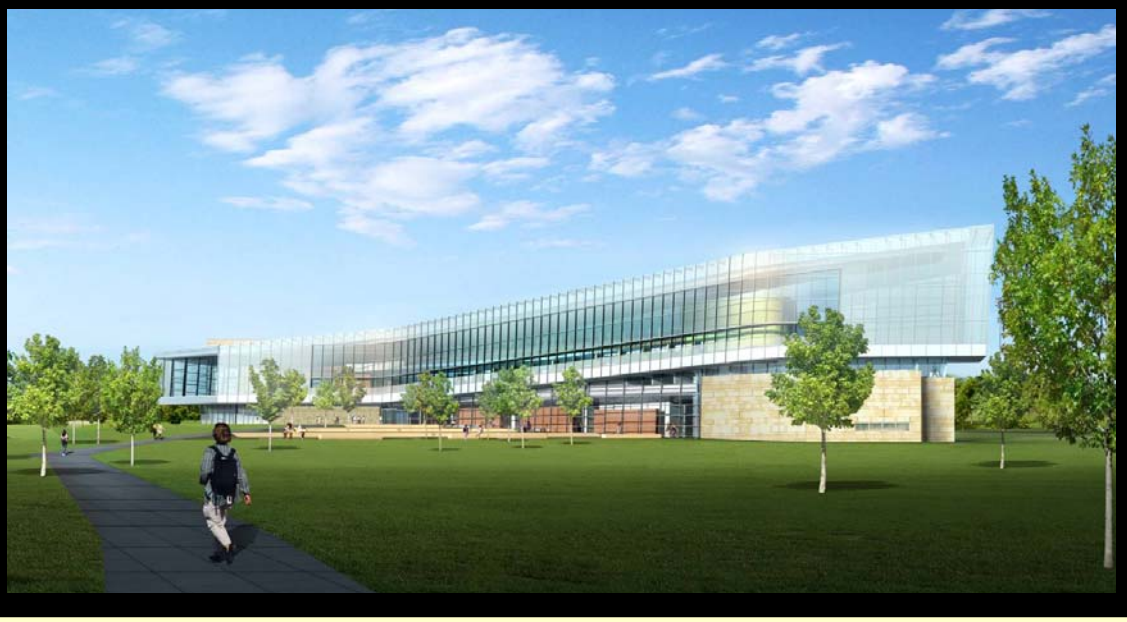
·THE NEW DICKINSON SCHOOL OF LAW·

University Park, PA
Steve Ayer
Construction Management Option



Thesis Proposal

Resubmitted: Friday, January 18th, 2007

CPEP Website: http://www.engr.psu.edu/ae/thesis/portfolios/2008/ska124/

Faculty Consultant: Dr. Messner

TABLE OF CONTENTS:

EXECUTIVE SUMMARY:

Based on the feedback received from Technical Assignment 3, this proposal was created to highlight the proposed areas of study for future research of the new Dickinson School of Law building located in University Park, PA. It has been concluded that the following specific areas will be examined for this project:

- **Proposed Building Analyses:**
  - BIM Research: This analysis will look at the problems facing certain trades with regards to BIM and 3-D modeling as it relates to building coordination.
  - Architectural Redesign of Key Building Elements: This analysis will examine the possibilities related to using both alternative materials and alternative building elements to reduce construction costs without sacrificing overall building quality.
  - Analysis of Glazing Alternative: This will involve proposing a new type of glass to be installed on the exterior glazing in the building which will consist of triple pane glass and may employ Building Integrated Photo Voltaics (BIPV) into the glass or shades to generate electricity from the sun.
  - Analysis of Utility Tunnel Construction: This final study will examine the feasibility and potential schedule savings of boring under Park Avenue to construct a utility tunnel under the road as opposed to the actual method of digging up the road.

- **Breadth Studies:**
  - Architectural Breadth Study: This breadth will involve using experience gained from prior architectural classes to propose alternative design elements to reduce building costs without hindering the overall building aesthetic. This goal will involve compiling a list of design changes, speaking with industry professionals to determine cost savings, and ultimately making a recommendation about each design alternative.
  - Mechanical Breadth Study: This study will look at how using the alternative glazing solution proposed in the analysis mentioned above could potentially save costs by sizing down some of the HVAC equipment used in the building. To perform this study a takeoff of the total area of glass in the building will be performed, the heat loss reduction will be calculated and the total heating/cooling required to be supplied by the HVAC equipment will (hopefully) be less such that some of the equipment may be sized down.

ANALYSIS DESCRIPTIONS:

Analysis No. 1: BIM Research

While it seems that the construction industry is often criticized for being slow to change and that we, as an industry, are set in our ways, the industry is indeed changing. One of the critical areas where change is rapidly being adopted is in the area of Building Information Modeling. BIM seems to be the new buzzword in the industry and some people are quick to tell of their success stories from using the technology while others are quick to use some different choice words to describe the technology that involve them getting headaches and frustrations from it.

It seems that the problem with BIM is related to a lack of understanding. This lack of understanding starts with the word BIM itself. To some people BIM means modeling what would be a 2D drawing in 3 dimensions. Others feel that this would not technically be embedding any information into the model and is therefore, not a true BIM. Some people feel that a true BIM should include every piece of information that could be found in a set of drawings and specs. It is still uncertain at this point if this is realistic or effective.

The misunderstandings related to BIM also span to the lack of understanding of how to use the software necessary to obtain value from BIM. Many people in industry today have never had a reason to model standard 2D coordination drawings in 3D, let alone embedding information into the model geometry. As a result many people are reluctant to give up the standard 2D drawing process.

More in-depth research should be done to determine more specifically what areas of the BIM process require more clarification for industry professionals. The goal of this research would be to determine which trades are typically at the back of the pack in understanding BIM and determine what it is that they lack in understanding of the process. From the contacts I made and spoke to at the PACE roundtable, AE career fair, and project jobsite, it is apparent that BIM is here to stay so ignoring it is not an option. As a future construction manager, it would be advantageous to learn now which trades will likely need the most help with utilizing BIM in construction and what areas will likely be the source of misunderstanding.

To properly conduct this research, it will be necessary to:

1. Assess what all of the possible uses for BIM are through interviews with faculty and industry members as well as reading engineering and construction documents.

2. Speak to some people in the real world who have dealt with this technology and ask for their thoughts about BIM.

3. Document their trade, prior coordination experience, and comments.

4. Conduct informal interviews with people on the site involved with the 3D coordination effort for the new Dickinson School of Law. Questions should be asked such as:
- Did you see value in the BIM coordination process?
- How much experience had you had with 2D and 3D coordination efforts prior to this effort?
- Did you view the BIM coordination model to visualize specific areas in the building where you would have otherwise looked at a set of paper plans?
- Are there any other uses for BIM that should have been used on this project?
- Would you welcome another opportunity to work with BIM?

5. Document Findings. Ultimately, the expected outcome of this effort is to clearly pinpoint the areas and trades where a lack of understanding or comfort exists related to Building Information Modeling.

Analysis No. 2: Architectural Redesign of Key Building Elements

Architecturally this building makes a bold statement. There is no doubt about that. What this building could potentially benefit from, however, is a more critical analysis to determine where the building's modern aesthetics should be understated in the interest of cutting costs. Some of the areas that could fall into this category are the curved and tilted interior walls in the building. These walls will require extra labor hours to construct and also will be more difficult to finish. Perhaps these walls could have been straight, vertical walls. This could potentially allow for a large savings and only minimal loss in building aesthetics.

Going along with the previous problem, another area where an alternative design should be analyzed is related to the main curtain wall on the building (CW-4). This curtain wall curves, tilts, and rises as it wraps the front of the building façade. The curve of the curtain wall follows the curve of the building footprint. This feature of the building makes a big architectural impact on

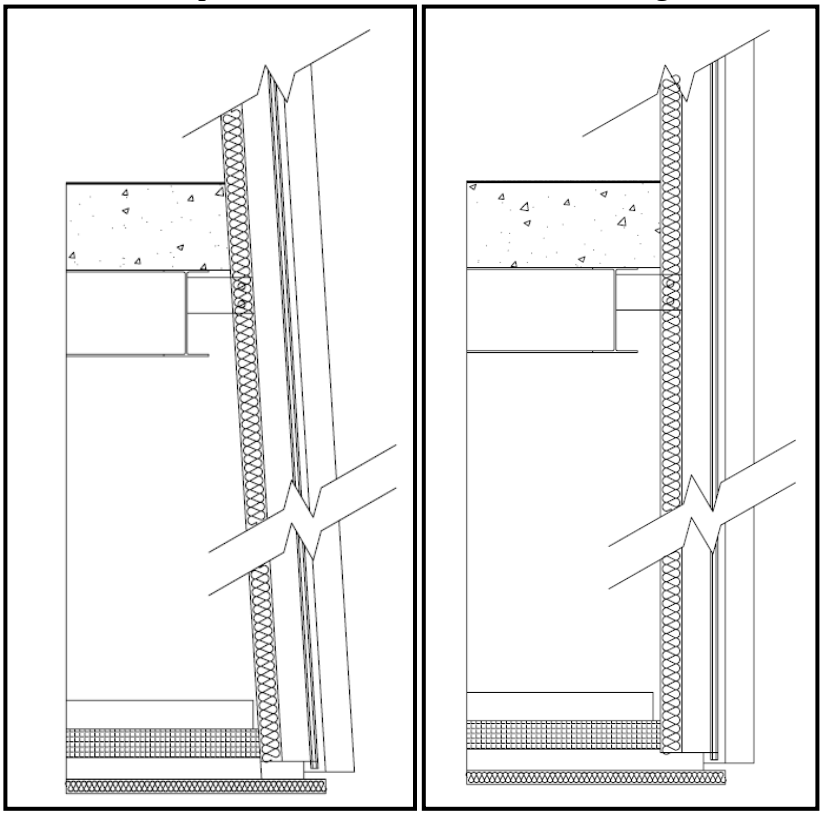


Figure 1: Possible Alternate Curtain Wall Detail.

the overall building aesthetic and it would probably not make sense to eliminate or redesign the curve of the curtain wall as a whole. While the curve of the curtain wall does make a great architectural impact on the look of the building, the tilt of the curtain wall mentioned earlier arguably will not. The tilt on the curtain wall changes along the curve of the building. It tilts from a minimum of -3.5° from vertical to +3.5° from vertical. Figure 1 shows the change if the curtain wall (at maximum tilt) was redesigned to be vertical. This appears to be a fairly subtle change. It may prove to be an interesting study to speak to industry professionals to assess the potential cost savings if the curtain wall was made vertical the entire length of the building.

Another architectural feature that could potentially save some construction costs on the project is the interior finish materials. There are three materials in particular that come to mind that add substantial costs; slate wall panels, and Anigre and European Red Elm millwork and finishes. The slate wall panels add a substantial amount of weight which needs to be accounted for in the design of the interior walls. In addition to the increased structural loads this type of accent requires, the shear cost of the material adds a staggering figure to the building construction. In addition to the slate accents in the building, the two wood species mentioned earlier also contribute to added costs. Anigre is a rainforest wood that is quite exotic and expensive. European Red Elm also provides a challenge for contractors because it is extremely difficult to locate a wood supplier who can obtain the necessary quantities of the wood. Both of these woods are not easy to locate and will not help in receiving any LEED credits during their long transit to site. Perhaps these materials could be replaced by local materials that could be cheaper and more readily available to contractors. Figure 2 compares Pennsylvania Cherry wood to Anigre. While there is a difference in the appearance of the woods it seems to be minimal. Cost analyses could be performed to determine the possibility of using Pennsylvania woods over the specified woods.

Figure 2: Interior finishes. Anigre (Above) and Pennsylvania Cherry (Below). Images found via Google Image.

This study will be one of the more substantial studies associated with this senior thesis project. The steps required to effectively Value Engineer this building and cost reduce some of the project's features will require:

1. Independent brainstorming of ideas to value engineer and cost reduce the project. This analysis will involve analyzing the plans and specifications for this project. A list of numerous ideas similar to the ones mentioned above should be generated.

2. It will then be necessary to review the list of ideas with Architectural faculty at Penn State, Construction Management faculty at Penn State, and industry professionals on the Dickinson Law School project site. The purpose of these reviews will be to determine which of these ideas will have the best chance of reducing costs without reducing value of the building project.

3. Once the list is trimmed down based on the conversations with the mentioned parties, discussions should be had with industry professionals to determine (where possible) what cost or time savings could be achieved by these new ideas for the project. It is important to note that some costs may be difficult to estimate. For example, removing the tilt on the main architectural curtain wall will likely save costs, but it will do so by simplifying the design, not reducing material costs. This may be difficult to throw a precise number at the exact savings of this design change. Where it is impractical to determine a specific value of savings, a qualitative examination of the benefits should be described based on the conversations had with the industry professionals.

4. Finally, the refined list of architectural revisions should be documented with all known benefits. As foreshadowed earlier, these benefits may include time savings, material cost savings, life cycle cost savings, etc.

The goal of this study would be to determine how much money would be saved by the proposed revisions where cost data is available and also to see if any additional LEED points could be obtained by utilizing local materials and minimizing transportation costs.

Analysis No. 3: Analysis of Glazing Alternative

In addition to the study on some of the architectural features of the project including the tilt of the curtain wall, it would also be interesting to look at the glass that is currently specified for the curtain wall and the rest of the building. As of now the glass on many of the curtain wall surfaces is supposed to be curved glass. Perhaps flat glass panes could be used instead. This could potentially save money, not skew any views from inside the building, make replacing broken panes easier, but still not noticeably affect the view of the building from any reasonable distance away.

In addition to analyzing the possibility of using flat glass panes, there is also the possibility of using highly efficient glass to minimize building operating costs. Because there is a substantial amount of glass designed in this project, the project would lend itself well to a study looking into this possibility. Double paned glass is currently being used on the building. It might be interesting to study how long it would take for a triple pane glass system to pay for itself by saving money on energy or potentially requiring smaller

HVAC equipment. In addition to this glazing analysis, Building Integrated Photo Voltaics (BIPV) could be integrated into the glazing, shades, or both. It could then be analyzed to determine how much additional energy would not only be saved by the triple pane glass system, but how much would be generated by the BIPV system. This life-cycle cost could indicate that a triple pane glazing system with BIPV should be used for future projects like this one.

This analysis would require a few steps to perform:

1. Perform a "takeoff" of the total square footage of exterior glass in the building.

2. Determine the cost of triple pane glazing systems and BIPV systems.

3. Determine the amount of power (watts or kilowatts) that could either be saved / generated by using these windows.

4. Determine if it would be possible to size down HVAC equipment as a result of the insulation gained from the new windows. If it is possible, attempt to find cost savings (operational and initial).

The goal of this study would be to determine what savings could be had on a yearly basis from both insulating properties and photo voltaic properties of the new glazing system. This savings would be weighed against the initial cost of the upgraded glass. A secondary goal of this study would be to determine what HVAC equipment could be sized down for this building. Where it would be possible, some calculations could be performed to determine what specific elements could be changed and propose an alternative equipment solution.

Analysis No. 4: Analysis of Utility Tunnel Construction

Another potentially problematic feature on this project was related to running the campus utilities under Park Ave. This construction activity might seem like a relatively easy task, but what made this job difficult was the fact that Park Ave is a state road. Therefore, the construction manager could not simply contact Penn State, let them know of the dates they would complete the work and shut down the road accordingly. As a result, the state had to be contacted and permits had to be issued. One of the stipulations in the permit was that westbound traffic had to be allowed to maintain use of the road during construction. This meant that half of the road could be demolished and the underground tunnel could be constructed while traffic was routed to the other side of the road. Then, after one half was built, the traffic would be redirected to that side of the road while the utility tunnel on the other side was constructed. The idea of boring under the road was proposed to try to avoid this whole process. Essentially, a tunnel would be bored under the road, the soil would be braced during construction, and the utility tunnel would be built while Park Avenue remained open.

It would be interesting to examine the feasibility of boring under the road to place the tunnel instead of digging up the road and closing down all eastbound traffic. This study would be accomplished through the following steps:

1. Obtaining information from the construction manager, engineer, and site work contractor to understand if it would indeed be possible to bore the hole, place the tunnel (using precast or cast-in-place concrete), and still abide by all OSHA guidelines.

2. When a possible method for this type of construction is determined, it would be necessary to look at the cost of this procedure as compared to the cost of digging up the road as it had been done in reality. This data could be obtained through conversations with the contractors involved in this effort.

3. Because of the permitting requirements of closing Park Avenue, this method may also help in reducing the schedule for running the utilities to the building. Therefore, potential time savings should be determined and documented based on conversations with the contractors and also the project superintendents.

The goal of this study would be to find out if this utility tunnel process could have been done faster or cheaper. Results of the conversations with the people mentioned earlier would be documented, and the pros and cons of constructing the utility tunnel would be weighed to determine if the proposed method of boring under the road could have been used instead of digging up the road.

WEIGHT MATRIX:

The weight matrix in Figure 1 below indicates the amount that my proposed analyses will touch on the prescribed topics listed.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction/ Acceleration Proposal	Total
BIM Survey	20%	-------	-------	-------	20%
Architectural Redesign	10%	20%	10%	-------	40%
Exterior Glazing Alternative	-------	10%	-------	10%	20%
Utility Tunnel Construction Process	-------	-------	-------	20%	20%
Total	30%	30%	10%	30%	100%

Figure 1: **Weight Matrix**

BREADTH STUDIES:

In the analyses listed in this proposal, there are two breadth studies that will be undertaken related to specific analyses. One will be an architectural breadth study related to the Architectural Redesign analysis. The other will be a Mechanical breadth study related to the exterior glazing alternative.

The architectural breadth study will involve looking to the knowledge and experience gained from prior years during architecture studios and lectures. This will require thought to be given to how to decrease costs without greatly decreasing visual appeal of the building. As mentioned earlier, this building makes a bold statement and if any changes were proposed to completely do away with the modern aesthetics of this building, those changes would be doing a clear disservice to the building's design and, ultimately, the university. Instead, special attention will need to be given to proposing materials and other design changes that have a very similar appearance to those seen in the current design.

The second breadth study to be performed in this thesis project will be related to the mechanical systems of the project. In the exterior glazing alternative breadth study, it was mentioned that with extremely efficient glass installed in the building, it would likely be possible to size down some of the HVAC equipment in the building. This process of actually calculating the energy savings and recommending alternative equipment to be used that will be cheaper both upfront and in the long run, will constitute the second breadth study for this project.