# KRISTOPHER J. BRICE

Construction Management
Faculty Consultant: Dr. Christopher Magent


## New Moon Area High School/ District Administration Offices

8353 University Boulevard, Moon Township, PA 15108

**Revised Thesis Proposal | 1/15/2010**

8353 University Boulevard, Moon Township, PA

# New Moon Area High School

## & District Administration Offices

Kristopher J. Brice | *Construction Management*

### STRUCTURAL SYSTEMS

**Foundation:**

Grade beams and columns bear on (299) caissons ranging from 24”-54” in diameter, at depths of 13’-40’.

**Superstructure:**

The ground floor is supported by grade beams spanned by a 21” ribbed, structural slab-on-grade. Floors 1-2 rest on 3-1/2” light weight concrete on 3”, 18 gauge metal decking. The buildings main support comes from a structural steel system made of varying W-shapes and the lateral loads are carried through masonry shear walls.

### MEP SYSTEMS

**HVAC:**

Classroom climates are provided by (130) in-ceiling heat pumps, (11) 100% outside air units with heat recovery, (3) natural gas boilers, and (2) fluid cooling units. Other space heating and cooling is supplied by a combination of (12) variable and constant volume AHU’s, and (15) cabinet heaters.

**Electrical:**

(2) 5000A, 480Y/277V 3Φ, 4-wire Service feeders are provided by Duquesne Light. The service is then dropped to 208Y/120 by (6) transformers within the building. Back-up power is supplied by a 17 minute UPS and a 250 kW diesel powered generator.

**Fire Supression:**

The building utilizes a combination of wet and preaction systems.

### ARCHITECTURE

The New Moon Area High School will feature a tan brick exterior with stone and red brick accenting, along with the occasional use of a glass curtain wall system. The building is of a split-level design, only allowing for only two of the three stories to be seen from the road. The High School is designed for the community spaces to be most accessible from the main entrance, where the auditorium and gymnasium are on the first floor, and the bulk of the classrooms are on the second floor. The ground floor consists of the cafeteria, natatorium and district administration offices. Overall, the building will accommodate 1,260 students and 172 staff members.

*Main Entrance*

### PROJECT TEAM

**Owner:**
Moon Area School District

**Architect & MEP:**
Eckles Architecture & Engineering, Inc.

**Building Electrical Engineer:**
Tower Engineering

**Structural Engineer:**
Barber & Hoffman, Inc.

**Civil Engineer:**
Michael Baker Jr., Inc.

**General Contractor:**
Nello Construcition Company

**CM Agent:**
N. John Cunzolo Associates, Inc.

### GENERAL BUILDING DATA

**Size:**
291,387 square feet

**Occupancy Class:**
Group E - Educational

**Cost:**
$63,682,117

**Dates of Construction:**
January 2009 - November 2010

**Delivery Method:**
Design-Bid-Build w/CM Agent

# Table of Contents

# Executive Summary

The following proposal serves as an outline for the research and analyses that I plan to conduct during the spring of 2010. The four analyses described below are a result of problems identified during the design and construction of the New Moon Area High School and District Administration Offices. Overall, the theme of the four analyses will be the use of Building Information Modeling during design and construction of new facilities.

### *Analysis 1: Development of a BIM Project Execution Plan*

The first analysis deals with the use and coordination of a Building Information Model. As a critical industry issue, the use of BIM can be very beneficial if properly executed. Research for this analysis will include the development of a BIM Project Execution Plan as described by the recently developed BIM Project Execution Planning Guide from the CIC Research Group at Penn State.

### *Analysis 2: Site Layout Redesign*

The second analysis incorporates that use of the BIM model to help develop a new site position for the high school. As the building is currently positioned there is not adequate space for construction storage and with the building footprint in place the site becomes very congested. Also, the current layout requires the installation of a large retaining structure in order to make room for new parking. The goal of this analysis is to develop a new site plan eliminating the need for the retaining wall while also creating a more efficient use of the property.

### *Analysis 3: Concrete Foundation Wall Redesign (Structural Breadth)*

As a result of the buildings split-level design there is a foundation wall that separates the ground floor of Areas C&E from the soil under the first floor. The installation requirements of the retaining wall have forced the building to be constructed in way that delays the achievement of a watertight structure. The goal of this analysis is to design an alternate foundation system for this area of the building that will help to accelerate the schedule and result in a more efficient construction sequence. This will also include the use of a BIM model to help create a new sequence of construction.

### *Analysis 4: Alternate Window System (Building Envelope Breadth/ M.A.E Study)*

The final analysis requires investigation into alternate window and curtain wall systems. The systems that are currently specified require the building's brick veneer to be in place prior to their installation. Through research a new system will be selected that will eliminate this requirement and prevent the need for temporary enclosures. Also, as part of the research an attempt will be made to specify a new system that will have thermal and moisture properties superior to the current system. This analysis will incorporate information gathered from AE 542: Building Enclosure Science and Design.

# Project Background

The construction of New Moon Area High School along with its accompanying district offices is the second stage of a master plan to revitalize the main campus of the Moon Area School District as depicted in Figure 1. The first two phases of the project consisted of roadway projects to relocate the campus' main entrance. This was followed by the demolition of the Carnot Building, an older campus building that had recently been condemned. The demolition of the Carnot Building made room for construction parking and a staging area. After the completion of the New High School, the old high school will undergo renovations to become the New Moon Area Middle School. Finally, upon the conclusion of the renovations, the previous middle school and district offices will be demolished to make room for practice fields and parking. The overall campus renovation is scheduled for completion during the summer of 2012.

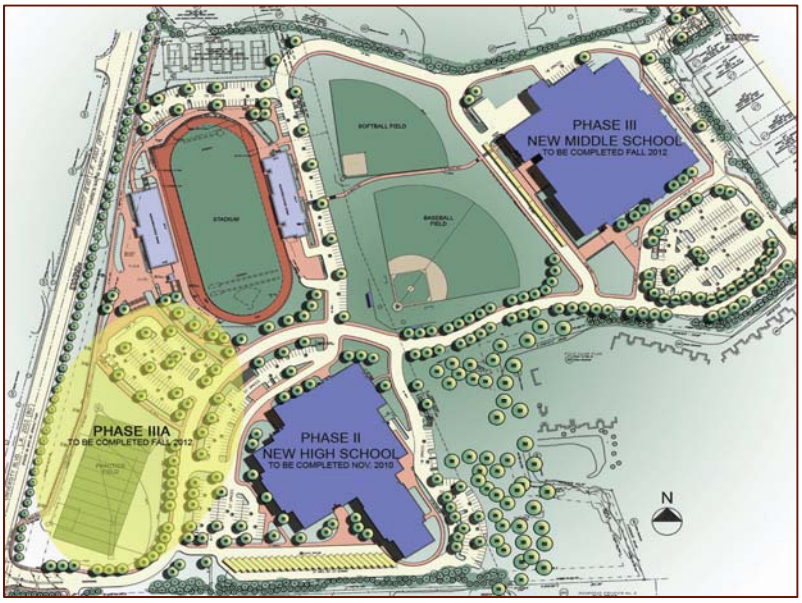



***Figure 1: Campus Phasing***

Upon completion the 291,400 $ft^2$ facility will provide education for 1,260 students and community access to a 1,200 seat auditorium. Along with the construction of the high school, phase two includes the construction of a new tennis facility to the north of the stadium. Also, a softball and baseball complex with accompanying concession stand will be placed in the area between the current high school and the stadium facility. Phase II began in February 2009 and is scheduled for completion by November 2010. The total construction cost for phase II is to be approximately $64 million. When completed, the exterior of the building with feature a mainly brick façade with strategically placed curtain wall accenting.

The high school is being delivered to the district using the traditional design-bid-build method with the addition of a CM Agent. The project architect is Eckles Architecture & Engineering, a western Pennsylvania firm well known for their work on public schools. The CM Agent, N. John Cunzolo is providing CM services for their first time on this project. Among the 13 prime contracts awarded, Nello Construction Company is the GC and lead contractor responsible for coordination and site logistics.

# Analysis 1: Development of a BIM Project Execution Plan

### *Opportunity for Improvement*

Over the past few years Building Information Modeling (BIM) has quickly become a popular tool for the design, construction and maintenance of facilities throughout the construction industry. However, with the ever changing technologies and new skills required to make BIM effective, it still remains a mystery to some. The resistance to BIM can also be contribute to the high level of coordination required to ensure that modeling is correctly executed and databases are available to all project members. In the case of the New Moon Area High School, the building and its systems were modeled using 3-dimensional software, but this was done strictly for design purposes. The project has the potential to benefit from many of the other uses for the models, including scheduling, coordination, and site utilization.

### *Goal*

The focus of this research will involve developing a BIM Project Execution Plan centered around the best uses for building models that have already been developed by the project team along with the use any additional models deemed necessary through analysis. The goal is to provide a complete plan, along with examples of project specific inefficiencies that could have been avoided.

### *Methodology*

- Contact Penn State's Computer Integrated Construction Research Program to gain a better understanding of the BIM Project Execution Plan.
- Conduct interviews with the lead architect and engineer to determine how extensively the models were used. Were the models used for MEP coordination? Was clash detection completed between the structural, architectural and mechanical models? Were the models used to help develop an overall project schedule? Were the models used for site coordination?
- Develop a prioritized list of uses for the BIM model by interviewing the owner and project team.
- Develop a project specific BIM Project Execution Plan.
- Analyze the final BIM model by performing tasks related to priorities set forth by the project team.
- Compare results to the current progress of the construction.

### *Required Resources and Tools*

- BIM Project Execution Planning Guide
- Autodesk Revit
- CIC Research Program team members
- BIM coordinating software
- BIM literature

### *Expected Outcome*

Through my research, I intend to develop a plan that, if used from the beginning of design, would result in a project that has fewer coordination issues and a more efficient construction schedule. The final BIM Project Execution Plan will provide the project team with the necessary tools to potentially offer the owner a better quality product in the end.

# Analysis 2: Site Layout Redesign

### *Opportunity for Improvement*

The current orientation of the building and layout of the site does not allow much room for construction activities to proceed. With the building footprint in place the site becomes very small forcing many of the contractors to utilize offsite warehouses for the storage of many materials that would normally be kept onsite. Along with causing construction congestion, the design calls for the installation of a pricey 30' tall retaining structure along the south side of building allowing for expanded parking near the district offices. Overall, the orientation of the building may potentially result in a higher construction cost due to these areas of concern.

### *Goal*

Through a thorough investigation of the original site conditions, my goal is to develop a site plan that complements more of the natural surroundings while also allowing for increased efficiency during construction. This research will be completed with the assistance of a BIM model developed for site utilization.

### *Methodology*

- Study geotechnical documents from original site conditions.
- Contact architect for logic behind site design.
- Develop multiple drafts of new building orientations.
- Compare and contrast designs, selecting the best value as final.
- Develop 3D site utilization model.
- Present model to contractors for feedback.

### *Required Resources and Tools*

- Geotechnical Reports
- Information on existing site conditions (climate, wind, sun, rain, etc.)
- Autodesk Revit
- Industry professionals

### *Expected Outcome*

With a little investigation I expect to find that a repositioning of the designed building will result in a more efficient use of the site, possibly even allowing for the elimination of the expansive retaining wall. This has the potential to result in both a savings of time and money. Along with this I hope to find that the building's new position will allow it to more efficiently use the sun's thermal energy. Finally, the reposition of the footprint should provide more space for the contractors to store equipment and materials, eliminating the need for offsite storage areas.

# Analysis 3: Concrete Foundation Wall Redesign (Structural Breadth)

### *Opportunity for Improvement*

As a result of the buildings split-level design there is a foundation wall that separates the ground floor of Areas C&E from the soil under the first floor, shown in Figure 2. As designed, the wall cannot be backfilled until the steel on the ground floor has been set and plumbed and the first floor slab-on-deck is placed. This is a problem because the grade beams under the first floor of Areas C&E tie into the wall and cannot be completed until the wall is backfilled. This also prevents the first floor slabs from being placed, which will further delay the installation of the load bearing masonry walls that surround the gymnasium and auditorium. The requirements of the wall have caused the building to be constructed as two separate pieces with a void between, resulting in a delay in achieving a watertight status. A possible redesign of the wall or the development of a temporary bracing plan may help alleviate this issue.

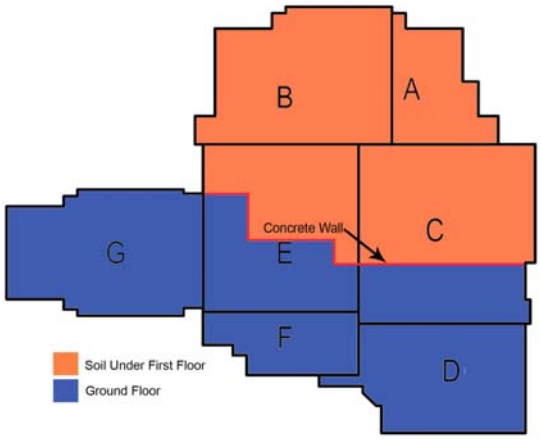



*Figure 2: Concrete Wall Location*

### *Goal*

The focus of this research is to determine an alternate wall system that will allow Areas C&E to be completed with the rest of the structure. The goal is to design a new system that will have a much smaller impact on the project schedule and help the building to become watertight at an earlier date.

### *Methodology*

- Contact structural engineer and general contractor to determine possible alternate systems.
- Design alternate system best suited for this situation.
- Analyze constructability of current system vs. alternate system.
- Analyze schedule implications of current system vs. alternate system.
- Analyze cost differences between both systems.

### *Required Resources and Tools*

- Geotechnical reports
- Industry professionals
- Scheduling software

### *Expected Outcome*

The design of an alternate wall system should eliminate the need for the building to be constructed in such a disjointed manner by alleviating many of the constructability issues related to the current design. The new design should also result in reduction of the overall schedule and an advancement of the overall building dry date.

# Analysis 4: Alternate Window System (Building Envelope Breadth/ M.A.E Study)

### *Opportunity for Improvement*

The current Traco window and curtain wall system that has been selected for the new high school cannot be installed until after the exterior brick veneer has been placed and cleaned by the mason. Due to schedule delays and other conflicts, the installation of the veneer has been delayed until the structural masonry for the gym and auditorium is placed. This has forced the installation of the windows to be delayed. As a result, the general contractor has been forced to spend time and money creating temporary enclosures in the areas where brick has been delayed and windows are not in place. This was done in order for fireproofing and other temperature sensitive activities to remain on schedule.

### *Goal*

The goal of this analysis is to recommend an alternate window/curtain wall system that will allow for installation at an earlier stage of the project. I also hope to recommend a system that will provide a higher level of thermal efficiency.

### *Methodology*

- Analyze existing system for aesthetics, constructability, and engineering properties.
- Research alternate options and select new system.
- Compare properties of both systems.
- Calculate structural requirements and thermal properties of alternate system.
- Determine schedule and cost impacts of selected alternate system.

### *Required Resources and Tools*

- Industry professionals
- Scheduling software
- Building envelope literature
- AE 542 materials

### *Expected Outcome*

Through investigation I expect to find a system that with resolve the constructability issues at hand. This should result in a reasonable time and money saving to the owner and general contractor. However, I do not know that achieving a higher level of efficiency will be possible without incurring a large added cost.

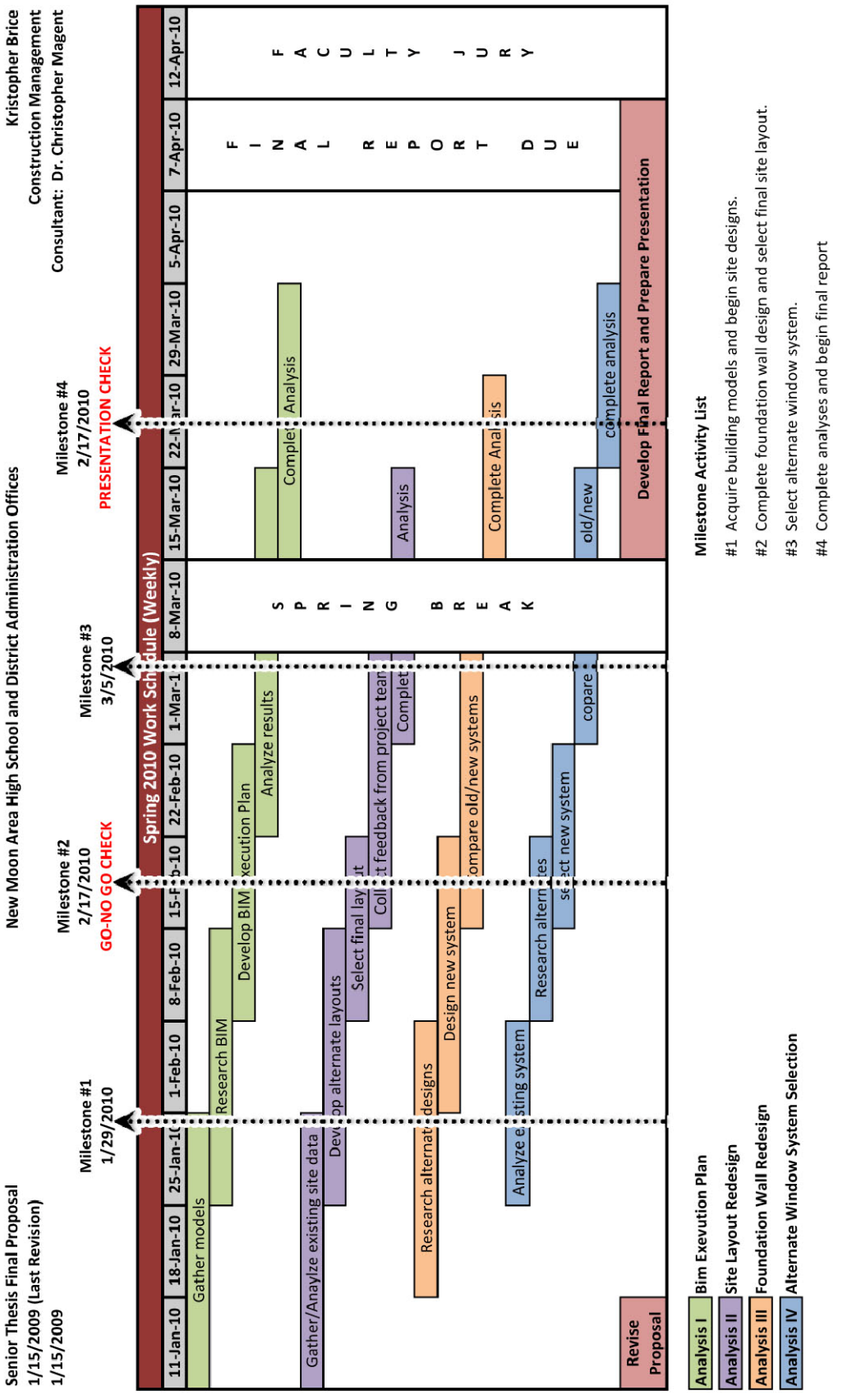
## Weight Matrix

The weight matrix below represents how I will be allocating my time to complete the four previously mentioned Analyses.

| Weight Matrix | | | | | |
|---|---|---|---|---|---|
| **Descriptions** | **Research** | **Value Engineering** | **Constructability Review** | **Schedule Reduction** | **Total** |
| **Analysis 1: BIM Project Execution Plan** | 25% | 5% | 0% | 0% | 30% |
| **Analysis 2: Site Redesign** | 5% | 10% | 0% | 5% | 20% |
| **Analysis 3: Foundation Wall** | 0% | 5% | 15% | 10% | 30% |
| **Analysis 4: Window/Curtain Wall Alternate** | 0% | 5% | 5% | 10% | 20% |
| **Total:** | 30% | 25% | 15% | 25% | 100% |

*Table 1: Work Matrix*

# Appendix A: Spring Semester Work Schedule


Senior Thesis Final Proposal
1/15/2009 (Last Revision)
1/15/2009
New Moon Area High School and District Administration Offices
Kristopher Brice
Construction Management
Consultant: Dr. Christopher Magent
Milestone #1
1/29/2010
Milestone #2
2/17/2010
GO-NO GO CHECK
Milestone #3
3/5/2010
Milestone #4
2/17/2010
PRESENTATION CHECK
Spring 2010 Work Schedule (Weekly)
11-Jan-10
18-Jan-10
25-Jan-10
1-Feb-10
8-Feb-10
15-Feb-10
22-Feb-10
1-Mar-10
8-Mar-10
15-Mar-10
22-Mar-10
29-Mar-10
5-Apr-10
7-Apr-10
12-Apr-10
SPRING BREAK
FINAL PROJECT DUE
Gather models
Research BIM
Develop BIM
Execution Plan
Analyze results
Gather/Anaylze existing site data
Develop alternate layouts
Select final layout
Collect feedback from project team
Complete
Research alternate designs
Design new system
Compare old/new systems
Analyze existing system
Research alternates
Select new system
Compare
Complete Analysis
Analysis
Complete Analysis
old/new
complete analysis
Develop Final Report and Prepare Presentation
Revise Proposal
Analysis I Bim Exevution Plan
Analysis II Site Layout Redesign
Analysis III Foundation Wall Redesign
Analysis IV Alternate Window System Selection
Milestone Activity List
#1 Acquire building models and begin site designs.
#2 Complete foundation wall design and select final site layout.
#3 Select alternate window system.
#4 Complete analyses and begin final report

# Appendix B: Breadth/ M.A.E Studies

### *Structural Breadth – Analysis 3: Concrete Foundation Wall Redesign*

In order to develop an alternative to the current concrete foundation wall, a series of structural analyses will need to occur. The new wall system will be required to meet or exceed all current design standards along with any additional construction loading that may result from the design of the new wall. Calculations will be performed demonstrating that the new wall system is capable of supporting all required loads.

### *Building Envelope Breadth – Analysis 4: Alternate Window System*

As a key part of the building envelope, the windows and curtains walls require extra attention to moisture and thermal properties as well as structural requirements. In order to accurately select a new system that will have the smallest impact on the current building design all of these elements must be considered. Simple calculations will be required to ensure that the building structure is capable of support the recommended systems. Also, the new window and curtain wall selections will need to meet or exceed the thermal and moisture properties of the current Traco system. This will require a series of calculations to determine adequacy.

### *M.A.E. Studies*

As part of my analysis into alternate window and curtain wall systems I plan to use knowledge and material gained from AE 542: Building Enclosure Science and Design. As I will be taking this class during the spring of 2010, I hope it will provide me with the necessary skills to accurately select a more efficient system for my building. Also, as part of all my analyses I plan to keep sustainability in mind and whenever possible utilize techniques and concepts that I learned during AE 597D: Sustainable Building Methods.