

Final Proposal



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Executive Summary

With every project there are many problematic areas that could be addressed and analyzed to help the project succeed. The Duffy School Addition and Renovation is like most projects and has several areas that need to be better analyzed. This proposal will look into several problematic features of the Duffy School Addition and Renovation. With the problematic features discussed, four areas of improvement on the project will be further analyzed. Several breadth topics will also be researched for the different areas of analysis.

Analysis 1- Lifetime Unit Energy Costs

This analysis focuses on improving the energy efficiency of the apartment units. This analysis will investigate three different aspects to keep the energy costs as low as possible for the residents. The first area of investigation will be to look into changing the batt installation in the exterior walls to either foam or blow in installation. This will look into the cost of each material and the time needed to install the installation. The next area of investigation will be making sure all the units are compartmentalized and completely air tight. Air sealing is usually difficult to do with existing buildings so for this area I will look into different options to adequately seal the existing units. The last area of investigation to keep the energy costs low is to use energy rated appliances. This will look into the lifetime costs of different apartment appliances.

Analysis 2- Lifetime Building Energy Costs

This analysis focuses on improving the energy efficiency of the common/shared spaces in the Duffy School. The area of investigation would be to see if solar panels can be placed on the building to help pay for the energy consumed in the common areas. This analysis will investigate the different solar panels available and their ease of installation.

Analysis 3- Prefabricated Exterior Wall Panels

This analysis focuses on schedule improvement with the use of prefabricating the exterior brick veneer. The Duffy School's new addition enclosure consists primarily of brick veneer façade and a small curtain wall. Covering large percentages of the building enclosure, the opportunity of using prefabricated panels or modular façade systems would potentially accelerate the schedule and reduce labor costs. By eliminating the use of traditional methods to enclose the building, the construction site would be less congested, offer higher quality and performance products, and help move quickly on the schedule.

Analysis 4- BIM Utilization

This analysis focuses on the use of BIM to improve the project. BIM was not used at all on this project but could have been used to improve the project in several ways. BIM could have been used from the start to turn the original school building drawings into electronic files. Having an electronic model of the building will have been able to show the problems with the as-built. Having an electronic model will also allow for the use of a clash detection software. Both reasons explained above should help to greatly reduce the total amount of RFI's and ASI's.

Table of Contents

Project Background.....	3
Analysis I: Lifetime Unit Energy Cost.....	4
Analysis II: Lifetime Building Energy Cost.....	6
Analysis III: Prefabricated Exterior Wall Panels.....	8
Analysis IV: BIM Utilization.....	10
Appendix A: Breadth Topics.....	12
Appendix B: Spring Semester Work Schedule.....	14

Project Background

The Marcella L. Duffy School was first opened in the 1870's and served as the first public school in the community. The school was closed down in 2008 due to the expensive costs of the outdated heating, ventilation and air-condition systems. The Duffy School addition and renovation will turn the original school into an affordable senior citizen apartment complex. The original school building will be turned into 35 apartment units. The addition, which will be on the east side of the school, will add another 18 units. In addition to the 53 apartment units there will also be a community room, fitness center, craft room, library, and an entertainment facility.

On the site for The Duffy School addition and renovation sits the original Marcella L. Duffy School. To the east of the school there is a parking lot and a small unoccupied house. To proceed with the addition to the school the parking lot and small unoccupied house had to be demolished. To the west of the school there is a blacktop that was used for outdoor sports including basketball and four square. South of the school is W. Second Street which is a two lane, two way road and to the north is a small one way alley. On the other side of the alley are residences in which the work shall in no way impede the use and occupancy of those properties and must be coordinated with the property owners.

The Duffy School is being delivered as a design-bid-build project. There was extensive demolition and removal of selected portions of the building and selected site elements. All existing mechanical systems were removed in their entirety including but not limited to the boiler system, piping, coils, valves, air handlers, etc. All the demolished materials were recycled wherever possible and any hazardous materials were disposed of in a safe manner. All existing plumbing systems were also removed in their entirety. The power and electrical systems remained active and had to be modified wherever needed. Due to the age of the school there were also numerous historical guidelines that needed to be followed according to the Duffy Urban Renewal Program and by Florence Township. All the black slate chalkboards and historical trim must be removed and carefully stored for reinstallation throughout the new building. All the historic tin ceilings and their patterns needed to be fully documented where they exist prior to any work. A piece of the cornice band, a piece of the border and a minimum of two square panels per room must be labeled and saved to be reproduced in the new building. The lobby columns and pediment vestibule also needed to be saved and protected during construction. This included completely covering the piece and not being able to work within a one foot radius of the historic piece.

The project started in April of 2014 and is to be completed in April of 2015. The project is estimated to cost right over \$9 million.

Analysis 1: Lifetime Unit Energy Cost

Problem

The Duffy School Addition and Renovation is going to turn an old elementary school into affordable apartments for senior citizens. Of the 52 new apartment units, 7 are held for households that make at or below 30% of the area medium income, 20 for households at or below 50% the AMI, 21 for households at or below 60% the AMI, and the remaining 5 will be for homeless seniors. The homeless seniors will have some of their food and clothes taken care of by the local Catholic Diocese of Trenton. With the incomes of the residents being low, the monthly costs to live in the apartments must be looked at. The rent is set and cannot be changed, but the energy consumption can be looked at and reduced in order to keep the bills as low as possible.

Research

After some research, there are three different areas of concern when looking at the energy consumption in the individual apartment units. The first area is the materials used in the wall system. The thermal resistance of different types of installation (batt, rolls, foam, and blow-in) can be compared as well as the time and cost associated with the different materials.

The next area of concern is reaching the required level of air sealing needed to comply with Tier 1 of the New Jersey Energy Star Homes Program. Two different options exist to adequately seal the existing shell boundary that each unit is framed within from the outside, adjacent units, and common spaces.

The last area of concern is the selection of appliances for the units. There are many different appliances that can be selected for the units. The energy consumed by the appliance and the initial cost of the appliances can be compared to see which will benefit the project in the long run.

Potential Solutions

After completing the analysis there are several potential solutions that could occur.

- The increase in the thermal resistance of the wall will outweigh the added cost of the different type of insulation and therefore should be implemented on the project.
- The cost of the new insulation material is too expensive and therefore will not be used on the project.
- The time it takes to install the new insulation will save time on the project and therefore should be implemented.
- The cost of the higher rated appliances is too expensive and therefore will not be used in the project.
- The cost of the higher rated appliances is more expensive but the lifetime savings are substantial, therefore will be used on the project.

Analysis Procedure

The following procedure should be completed to successfully analyze the lifetime unit energy costs associated with the individual apartments in The Duffy School Addition and Renovation.

- Research different types of insulation used for residential units.
- Research installation methods of different insulation materials.
- Research different techniques to air seal the units.
- Look into requirements of Tier 1 of New Jersey Energy Start Homes Program.
- Investigate different types of appliances based on energy consumption and cost.
- Look into long term energy savings of the appliances.

Predicted Outcome

Changing the installation material will increase the thermal resistance of the wall system which will allow for less energy consumed in the apartment units. The less energy consumed will allow for lower monthly bills which will greatly benefit the residents. The time to install the new insulation material will not be effected much so the overall schedule will stay on pace.

The use of higher energy rated appliances will decrease the energy consumed in the units. The costs will be higher to install the products but the lifetime savings will outweigh it. Again if the apartments are using less energy, the residents will be happy because they are paying less each month.

Analysis II: Lifetime Building Energy Cost

Problem

As stated above the Duffy School Addition and Renovation is going to turn an old school into apartments for low income senior citizens. As well as the 52 apartments the new building will also come with amenities. These amenities include a community room, fitness center, library, craft room, and entertainment room. The one problem with all these extra rooms is figuring out how the energy used in those areas will be paid for.

Research

After some research there are two areas of concern for the energy used in the shared spaces in The Duffy School Addition and Renovation. The first area is the incorporation of a photovoltaic system. The photovoltaic system is a good option for buildings that have the proper sunlight needed and have enough space for panels. The cost of the panels can be compared to long term savings. The amount of panels, men needed, and time of installation can also be researched.

The next area of concern is replacing two air handler units that supply air to the common spaces with a split system floor mounted heat pump/air handler. The costs associated with the different system can be compared. The energy used by each system can also be compared to see which will cost less in the long run. The installation time and men needed can also be compared.

Potential Solutions

After completing the analysis there are several potential solutions that could occur.

- The upfront cost of solar panels is too high and therefore will not be used.
- The amount of solar panels needed to power the common spaces is too large and there is not enough space for the panels.
- There is enough sunlight and the savings outweigh the upfront costs. If this is the case the solar panels will be used.
- The historical aesthetic of the building is compromised and therefore the solar panels should not be used.
- The new mechanical system in the common area can adequately heat and condition the space and therefore should be implemented.
- The new mechanical system uses too much energy and therefore requires the use of more solar panels. More solar panels will cost more money and therefore the new system will not be used.

Analysis Procedure

The following procedure should be completed to successfully analyze the lifetime building energy costs associated with the common spaces in The Duffy School Addition and Renovation.

- Research different types of photovoltaic systems.

- Calculate amount of energy used in the common spaces.
- Look into sunlight properties of the site.
- Research split system floor mounted heat pump systems.
- Compare AHU's to heat pumps.

Predicted Outcome

After seeing how much energy gets used in the common spaces, the goal is to encourage the owner to put the money towards the cost of the photovoltaic system. The photovoltaic system will help save the residents and owner money from not having to pay for the energy in those shared spaces. The installation of the panels should not add time to the schedule because it can be done concurrently while interior work is completed. The solar panels will also add enough value to the project that even with the panels, the aesthetic of the building will not be changed. The cost of changing the air handling units to a floor mounted heat pump will also be too high and therefore that change will not occur.

Analysis III: Prefabricated Exterior Wall Panels

Problem

The Duffy School Addition and Renovation is concerned with keeping the building on the set schedule. The completion date is very important to be able to get the senior citizens moved in. The project is already three weeks behind schedule. To get the project back on schedule either certain activities need to be accelerated or more men need to be added to the project. The entire new addition will have exterior brick masonry that has to match the masonry on the existing building. Brick masonry is typically a slow moving activity due to the high level of craftsmanship and the physical strength required to put the materials in place.

Research

After some research there are three main areas of concern when looking into prefabricating the exterior brick façade. The first area of concern is making sure the aesthetics of the brick façade do not change once the prefabricated system is installed. The brick on the new addition has to be similar to the look of the brick on the existing building. The façade of the new addition has to have a historical feel to it like the brick on the existing building.

The next area of concern is finding out how the prefabricated brick panels will be attached to the structure. Prefabricated brick veneer panels will have to be researched more fully in order to find the right system that will connect to the exterior frame, meet the thermal performance required, and still meet the aesthetic qualities needed on the project.

The last area of concern is figuring out the cost savings or cost added to the project with the manufacturing and installation of the prefabricated system. The cost per square foot to manufacture the panels will be analyzed as well as the cost to get the system to the jobsite. The cost and durations of installing the new panels will also have to be researched more in-depth.

Potential Solutions

After completing the analysis there are several potential solutions that could occur.

- Prefabricating the buildings brick exterior façade could be found to not be feasible due to the raise in cost and the inadequate time saved in the schedule. If this is the case the prefabrication will not be implemented.
- Prefabrication of the building's brick exterior skin could be found to save time and money and therefore should be implemented on the project.
- The costs of designing, transporting, and delivering the prefabricated brick wall panels to the jobsite can be found to be not financially feasible and therefore should not be implemented.

Analysis Procedure

The following procedure should be completed to successfully analyze the prefabrication of the exterior wall panels.

- Research different types of prefabricated brick veneer systems.
- Research case studies of similar projects that used prefabrication.
- Determine costs for the original method of construction and productivity rates.
- Examine the building's exterior envelope design and determine the most feasible construction sequence for installing the brick wall panels.
- Calculate costs for off-site prefabrication and off-site staging locations.
- Figure out how it will be installed and the equipment and man power needed.

Predicted Outcome

Prefabricating the brick exterior envelope of The Duffy School Addition using brick wall panels should result in significant cost and schedule savings. By prefabricating the building enclosure offsite and installing the full panels as they arrive on site, the projects schedule should be reduced while also reducing the amount of labor needed on site which in turn will save money. Additionally, an increase in worker productivity with an easier and faster construction sequence, will also contribute to a shortened construction schedule.

Analysis IV: BIM Utilization

Problem

The schedule is a main concern for the owner. The project needs to finish on time so the residents can move in. One main issue that has held the project up is that the as-built drawing for the original school is not correct. Doorways are feet from where they are supposed to be, windows were not in the correct locations, dimensions were missing, etc. The as-built being incorrect has caused over 72 RFIs (request for information) and around 24 ASI's (architects supplemental information). All these RFI's and ASI's take time to get answers, which can cause major schedule delays.

Research

BIM has many uses in the construction industry. BIM can be used for 3D coordination, site utilization planning and analysis, structural analysis, digital fabrication, and facilities management. Since the drawings were never put into 3D format, clash detection could not be used and this resulted in the increased amount of RFI's on the project.

My main focus will be utilizing 3D coordination. BIM could assist in the coordination of the different systems and would have been able to find errors in the as-built drawings a lot earlier for the project.

Potential Solutions

After completing the analysis there are several potential solutions that could occur.

- The cost of creating the 3D model is too high and outweighs the costs saved from the use of BIM. If this is the case, BIM will not be utilized.
- The amount of time saved by limiting RFI's is substantial and therefore BIM should be utilized.
- The amount of time added by the creation of the 3D model is more than the time saved and therefore BIM should not be utilized.

Analysis Procedure

The following procedure should be completed to successful analysis the use of BIM on the Duffy School Addition and Renovation.

- Determine the different uses of 3D models for coordination.
- Look into reasons the owner decided to not use BIM initially.
- Evaluate the costs of a 3D model.
- Look into the estimated costs associated with change orders.
- Evaluate the duration of creating the 3D model.
- Determine possible schedule savings by limiting the number of RFI's.

Predicted Outcome

With the use of 3D coordination the predicted outcome for this analysis is that BIM will be very useful. A 3D model of the existing building will help substantially by preventing RFI's and change orders. With the 3D model complete, clash detection software could be used which will again limit the amount of RFI's and will save time for the project.

Appendix A: Breadth Topics

Breadth Topics

Mechanical

This breadth will incorporate Analysis 1. In this analysis the lifetime energy costs of the individual apartment units will be investigated. This breadth will delve into the use of different wall installation materials and how it relates to the thermal energy performance of the wall system. The typical installation materials (batt, foam, and blow in) will be researched and analyzed to determine the best energy performance. The thermal resistance of the different wall systems will be analyzed to see the best fit is for The Duffy School.

Electrical

This breadth will incorporate Analysis 2. In this analysis the lifetime energy costs of the common areas of the building will be investigated. This breadth will delve into the use of solar panels to power these areas. The different types of solar panels will be researched as well as the amount of panels needed to properly power the different areas in the building. The electricity consumed in the common spaces will be calculated to see which solar panels should be used and how many are needed. The goal would be for the solar panels to power the mechanical system and lighting in the shared spaces.

Architectural (Possible Alternative)

This breadth will incorporate Analysis 2 &3. In these analyses the use of solar panels is researched as well as the use of a prefabricated exterior wall system. This breadth will delve into the visual impact the solar panels and the prefabricated wall systems will have on the Duffy School. The different types of solar panels will be investigated as well as ways to conceal the solar panels to make sure the desired historical architectural appearance is maintained. The prefabricated wall system will also be investigated to make sure it is watertight, as well as making sure it is visually similar to the existing building façade.

Appendix B: Spring Semester Work Schedule

Spring 2014 Semester Work Schedule January 2014-April 2014				The Duffy School Addition and Renovation								Jeremy Drummond-CM Anumba						
Milestone #1 1/23/14		Milestone #2 2/14/14		Milestone #3 3/6/14		Milestone #4 4/3/14												
1/12/14	1/20/14	1/27/14	2/3/14	2/10/14	2/17/14	2/24/14	3/3/14	3/10/14	3/17/14	3/24/14	3/31/14	4/8/14	4/13/14	4/21/14	5/1/2014			
CPEP								S p r i n g B r e a k				F i n a l R e p o r t	P r e s e n t a t i o n s		S e n i o r B a n q u e t			
	Analysis III																	
			Analysis I															
			Mechanical Breadth															
				Analysis II														
					Electrical Breadth													
									Analysis IV									
														Presentation Prep				
																	CPEP	

Legend		Milestone Activity Summary	
Analysis I: Lifetime Unit Energy Costs		Milestone 1	33% of Analysis III
Analysis II: Lifetime Building Energy Costs		Milestone 2	100% of Analysis III
Analysis III: Prefabricated Exterior Wall Panels		Milestone 2	90% of Analysis I
Analysis IV: BIM Utilization		Milestone 2	100% of Mechanical Breadth
Breadths		Milestone 3	100% of Analysis I
General Maintenance		Milestone 3	100% of Analysis II
No Work Periods		Milestone 3	50% Electrical Breadth
		Milestone 4	100% Electrical Breadth
		Milestone 4	100% Analysis IV
		Milestone 4	90% Final Report