

# Tech Report 3



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## Executive Summary

This technical report is an alternative methods analysis for the Duffy School Addition and Renovation located in Florence, New Jersey. This report explores schedule acceleration scenarios, value engineering topics, constructability challenges, BIM use evaluation, and research ideas from the PACE Roundtable.

Schedule acceleration is important on this project due to the need to quickly turn over the apartment units. Gary Gardner Construction would like to build these apartments as fast as they can to make as much profit as possible. To be able to achieve this, the critical path of the schedule was analyzed. The most important milestones for the project team is to pass every inspection. If all inspections pass without problems, the project should finish on time. Even if the critical path is followed perfectly some problems still exist that can cause delays. The main problem is the harsh weather in the area and the other problem is the difficulty in procuring the building materials. An interview was conducted with the project manager, Dominic DiSantis, to discuss ways to accelerate the schedule. The two main ways discussed were to hire more workers or to change the project to an integrated project delivery.

Value engineering was used on the project, but was not a top priority. Most of value engineering used on the project was related to appliances and finishes used in the apartments. This included changing the refrigerators in the units and using engineered floors instead of hardwood. Value engineering was also used to compare the difference between using an air handling unit to heat the community room or to substitute it for a split system floor mounted heat pump.

There are several constructability challenges surrounding The Duffy School Addition and Renovation. Some of the challenges include acquiring the construction materials, weaving in and out of the old structure, and the construction of the connecting section. Some challenges, like acquiring materials, not only affected the cost of the project but also the schedule. The other constructability challenges do not really affect the cost of the building but do have a big part in schedule delays.

The annual PACE Roundtable Event was comprised of a couple breakout sessions that were intended to help develop research topic's to analyze for the construction of The Duffy School Addition and Renovation. The event provided a professional forum for both industry members and students to discuss and collaborate on their thoughts relating to the industry's most up and coming topics. The event is not just designed to provide the students with possible research topics but also to provide industry professionals with varying opinions of the construction industries newest ideas.

The end of the Roundtable event included a personal session with an industry member to discuss possible ideas for thesis proposals. Students were able to take what they learned during the sessions and have industry members review the ideas. The industry members then gave some insight and criticism to what would be more relative to the industry.

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## Schedule Acceleration

### Critical Path

The schedule is a very important factor to the owner of The Duffy School Addition and Renovation. The critical path is used as the main baseline for the twenty four month schedule for the project. The activities on the critical path have been put into six main groups as shown in Figure 1 below.



Figure 1- Critical Path Activities

The critical path is crucial to completing the project on time. To make sure the project is moving along with the schedule, inspections are completed after the completion of each task on the critical path. If the inspections pass, the project completion date will stay the same but if for some reason an inspection fails, the project will be delayed.

### Schedule Risks

One of the biggest risks to the critical path of the schedule for the Duffy School Addition and Renovation is the weather. Being in South Jersey, the site will experience all kinds of weather, including very cold temperatures and large amounts of snow and rain. During the start of construction in mid-April until October, the weather did not play a huge role and the project was not affected. Once the temperature started to get cold in late October, the weather started to play a role in affecting the schedule. The first problem is the temperature inside the building is colder than outside the building. The façade for the building is 24" thick brick, so once the brick got cold, keeping the inside of the building warm became harder. Having the inside of the building colder than the outside is not only bothersome to the workers, but can also delay the schedule. The drywall for the Duffy School ended up getting a little wet during construction, which usually is not that big of a deal. Since the building is so cold, the dry wall is not drying as fast as needed and has already pushed the schedule back over a week.

### Acceleration Methods

For the Duffy School Addition and Renovation there are two basic methods to accelerate the project. The first method would be to increase manpower. This can be done by working longer hours or by hiring more crew members. If more crew members were hired, many different tasks would be able to be completed quicker. The current schedule has the task of painting each unit taking six days. If one other crew member was added on to this task, the total duration would be halved and would save the project three days per unit.

In an interview with Dominic DiSantis from Gary Gardner Construction, he explained one way this method was already implemented on the project. For the wood framing in the new addition, an extra two crew members were hired from Quisil Construction. These extra two members allowed the new addition framing to be completed six days ahead of schedule. Although extra costs were incurred by the

addition of two extra crew members, the costs were counteracted by the reduction in the project schedule.

The second method to accelerate the schedule would be to change the project to an integrated project delivery method. This would allow for open communication and would reduce the time it takes to get answers from the architect, owner, and other crews on site. Dominic explained to me that there are regular site meetings every first and third Tuesday of each month. The owner, architect, and engineers all attend these meetings. This allows for open communication during these meetings, which saves time not having to wait for responses.

## Value Engineering

Value engineering was used on the Duffy School Addition and Renovation, but was not a top priority. Most of value engineering used on the project was related to appliances and finishes used in the apartments. Value engineering was also used to compare the difference between using an air handling unit to heat the community room or to substitute it for a split system floor mounted heat pump.

### Appliances

The first topic for value engineering that was implemented on the Duffy School Addition and Renovation was to substitute the high end whirlpool side by side refrigerator for a slightly cheaper GE top freezer fridge. It was first discussed by the owner and project team to put in the side by side refrigerator to make it easier access for the senior citizens living in the apartments. After some analysis, the owner decided to go with the cheaper top freezer fridge. The refrigerator serves the same purpose as before, is still energy rated, and saves the project money. The owner made a relatively easy choice in changing refrigerators.

### Finishes

The second topic for value engineering that was implemented on the Duffy School was to substitute the finishes. An example of this was to use engineered flooring instead of hardwood floors. This decision was not made because of price, but due to the performance of the engineered flooring. Engineered floors are better suited for the different levels of the building because they perform better in different pressures and humidity conditions. Engineered floors also last longer under loading which will help with the life cycle of the building.

### MEP

The final topic for value engineering that was discussed but not implemented was to take out two air handler units and replace them with a split system floor mounted heat pump/ air handler. These two air handler units supply the air to the large community room on the first floor. This topic was analyzed to see if the floor mounted heat pump would be cheaper while still providing the proper interior conditions. After researching the floor mounted heat pump, it was decided by the project team that even though it would be cheaper to install the heat pump, the air handling units would be better suited to condition and heat the large space in the long run.

## Constructability Challenges

There are several constructability challenges surrounding The Duffy School Addition and Renovation. Some of the challenges include acquiring the construction materials, weaving in and out of the old structure, and the construction of the connecting section.

### Material Procurement

One of the biggest challenges for the Duffy School is the procurement of materials. Most of the materials used for the building are made to fit specifically for this project. The original building was constructed in the early 1900's, so there is nothing common about most of the pieces. Examples of this occurred when the brick for the addition came to the site from a local supplier. The addition brick had to be similar to brick used on the old school building. The brick that got delivered was not close enough to the existing brick, so it got rejected and a new supplier in West Virginia had to be used. This not only affected the schedule by taking took longer to get to the site but the cost went up due to the further distance of shipping.

### Existing Structure

One big challenge of renovating a building is having to work within the structure that already exists. This project was unique because the existing building is comprised of small classrooms which will be turned into apartments. Each new apartment gets fit into one-three existing classrooms. For the larger apartments, renovating several classrooms becomes a challenge. The classrooms already have windows and doors in place. Coordinating the new apartments to utilize the existing features took the project team a good amount of time. Another challenge is the extra time needed to move from classroom to classroom. If a new apartment utilizes two classrooms, the interior connecting wall could not be removed right away. Due to this, just moving from one classroom, into the hallway, than into the next classroom takes the workers time. If each unit was just a large open space it would not be a problem moving around the space, so it each unit could be completed quicker. The project team would have liked to remove the walls between the classrooms, but they were not able to do that because many of the walls provided structural support and could not be removed until the project is further along.

## Connection Section

The Duffy School Addition and Renovation has three main sections: the existing building, the addition, and the connection section. One big challenge with moving forward on the project is completing the connection section. The connection section, as seen on the right, includes a corridor, stair tower, and an elevator shaft. This section also includes all the utility lines, including gas, lighting, plumbing, etc. The lines come from the existing building and get connected to the addition in the connection section. This connection section not being completed on time is causing the whole project to slow down. The framing in the addition is ahead of schedule but the next stage of work cannot be started until all the connections are made to the existing building.

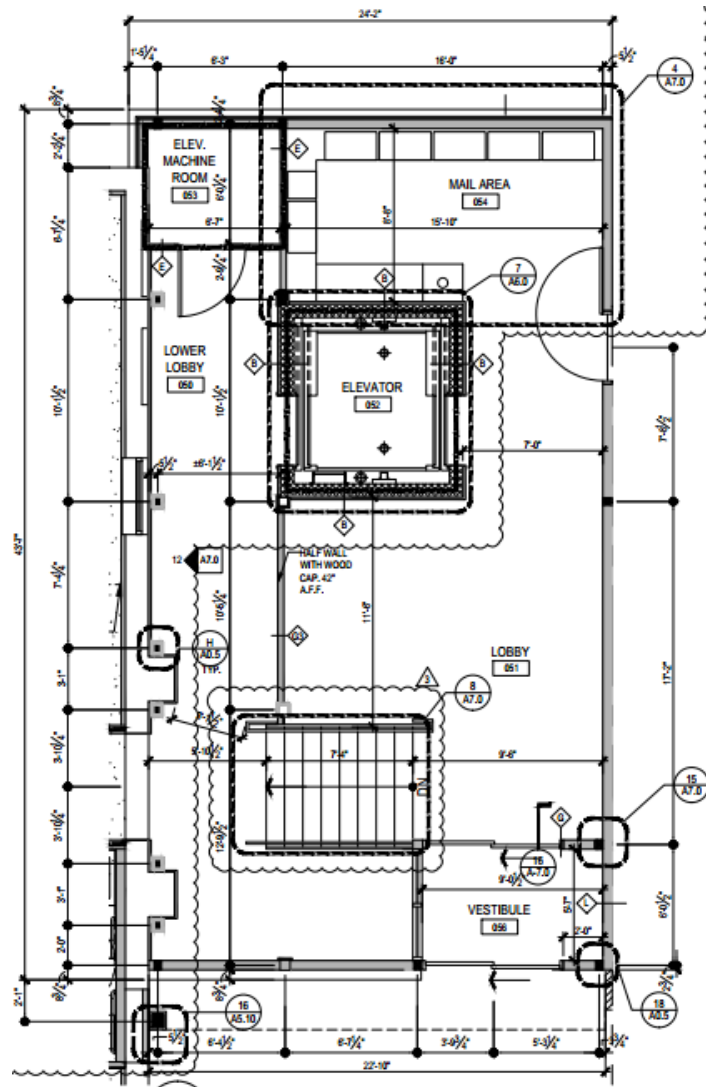


Figure 2- Connection Section



## BIM Evaluation

BIM for this project was not used at all.

X	Plan	X	Design	X	Construct	X	Operate
	Programming		Design Authorizing	X	Site Utilization Plan	X	Building Maintenance
X	Site Analysis	X	Design Reviews	X	Construction System		System Analysis
			3D Coordination		3D Coordination		Asset Management
		X	Structural Analysis		Digital Fabrication		Space Tracking
			Lighting Analysis		3D Planning		Disaster Planning
		X	Energy Analysis		Record Modeling		Record Modeling
			Mechanical Analysis				
			Other Analysis				
		X	Sustainability				
			Code Validation				
	4D Modeling		4D Modeling		4D Modeling		4D Modeling
X	Cost Estimation	X	Cost Estimation	X	Cost Estimation	X	Cost Estimation
	Existing Conditions	X	Existing Conditions	X	Existing Conditions	X	Existing Conditions

Figure 3- BIM Use Chart

When looking at BIM for this project, several areas could have been improved with the use of BIM. These areas include utilizing phase planning, 3D coordination, design reviews, and record modeling.

### Phase Planning

A 4D model could have been used to effectively show the construction sequence and the different phases of construction. This would identify space and workspace conflicts and would be able to resolve these issues ahead of the construction process. This would have helped to avoid the schedule set back due to the extra time needed to complete the connection section of the Duffy School.

### 3D Coordination

Performing 3D coordination could have helped on the project where new utility equipment (MEP system) runs through the existing building. A 3D model would help with clash detection and would have eliminated the major system conflicts prior to installation. A 3D model would reduce many field conflicts, which would greatly reduce RFI's. With less time being spent creating and waiting on RFI's, the project schedule would accelerate.

### Design Reviews

Creating a virtual prototype could have been useful when designing the common spaces. The owner visits the site every other week to check on the project and make some changes if necessary. If a virtual prototype was utilized before the start of construction, the owner would have better understood the use of all the different spaces and would have been able to make the changes earlier on. This would have saved the project time and money due to the high cost of change orders.

### **Record Modeling**

Gary Gardner Construction has past experience in the construction of low income apartments. If they used BIM on their past projects, they would have had different models to look at and compare to help eliminate future problems. Also maintenance of the Duffy School and future projects they work on would be much easier to complete if they used and saved their models.

## Critical Industry Issues

### PACE Roundtable

During the annual PACE Roundtable Event, held in the Presidential Suite at Beaver Stadium, a couple breakout sessions were attended to help develop research topic's to analyze for the construction of The Duffy School Addition and Renovation. The event provided a professional forum for both industry members and students to discuss and collaborate on their thoughts relating to the industry's most up and coming topics. The event is not just designed to provide the students with possible research topics but also to provide industry professionals with varying opinions of the construction industries newest ideas. The summaries below of the feedback taken from the two sessions I attended will be used later to develop research topics to analysis.

#### Session 1-Assembling Effective Cross-Functional Teams

This session discussed effective ways to assemble a team for the integrated project delivery method. The session started by discussing the current challenges to assemble and integrate teams across multi-disciplines. The two main challenges are the experience of subcontractors and also the embedded culture that already exists in the construction industry. The integrated project delivery method is relatively new to the construction industry and not many subcontractors know anything about it. Due to this fact, picking subcontractors becomes a challenge and is one of the main reasons more projects do not use IPD. The second challenge was the embedded culture in the industry. The professionals in the industry have been doing design-bid-build, or design-build all their life so bringing this large change of IPD is not easy. People do not like to change what they have been practicing their entire life.

The next part of the session discussed some improvements that need to happen to allow more projects to use IPD. One main improvement that needs to happen is everyone on the project needs to be aligned from the start. This includes everyone from the owner to the architect to the individual subcontractors. Getting aligned will allow everyone to know the goals of the project and therefore everyone can work together to make sure the goals get accomplished. The other improvement that needs to happen is there needs to be more preparation time before implementing IPD. An example was discussed how when new employees join a company they get over two weeks of learning and preparation before they get thrown into the field. Just like new employee training, IPD training needs to happen. Most companies give an hour or less to prep time and this just is not enough.

The one thing that surprised me in this session is when one of the industry professionals compared interviewing the future project team to interviewing new employees. The project team is very important to the success of the project. If the project team works well together and gets along, completing the project will be a lot easier. Most companies make some phone calls or pick crews off price. For IPD to be a success the interviews need to be more in-depth to find the best fit.

#### Session 2-Incentivizing Team Performance

This session discussed effective and ineffective ways to incentivize the project team. The session started out by talking about the negatives of incentives. The two negatives we talked about surprised me. The first incentives we talked about are safety incentives. The negatives of safety incentives is that an employee might get injured on the jobsite, but will not report it because they do not want to effect the

safety record. This can be very dangerous and cause problems if all injuries are not properly reported. The next incentive we talked about was limiting the number of RFI's on the project. The main negative of this is that all RFI's might not get submitted to keep the number down. If the RFI does not get submitted, the problem might not be fixed and could cause problems.

The next part of the session discussed some incentives companies currently use. The first incentive we talked about was pretty simple but was called the "atta boy" incentive. This just involved walking around the site and if you see a crew member doing good work, you go to them and tell them they are doing a good job. This keeps moral up on the site and makes people do better work so they can get the recognition. The other incentive one of the industry members talked about was having lunches for the crew members and bringing in a guest. One example was a team was building a church and at one of the lunches the Bishop stopped by and thanked the entire crew. This gave the crew a sense of purpose and made them want to succeed.

## Feedback from Industry

After the second set of breakout sessions, students had the opportunity to be paired with an industry leader to discuss possible research ideas for their proposals. Students also discussed what they had learned in the previous sessions and how it relates to their thesis building. The industry leader I spoke with was Mike Arnold, who is the owner's representative for the construction of the new Cardinal Wuerl North Catholic High School right outside of Pittsburgh. We were able to briefly discuss some of the ideas that I gathered from the day. It was recommended that looking into the front end costs of the integrated project delivery method is most relevant to the industry. To use the IPD method, the crews need to be hired earlier on the projects, so they can work together from the start. Hiring crews earlier on will cost more. Mike Arnold discussed how even though there will be more costs up front, in the end the project will save money compared to other project delivery methods. He suggested I research some projects that have used IPD and try to find exactly how much more money is needed earlier on in the project and how much will be saved in the long run.

Some contacts I received during the sessions can be seen below.

- Mike Arnold- Owner's Representative
- Ken Lindsey- Southland Industries
- Kendall Nielsen- LEED AP for Mortenson

## Appendix A- PACE Roundtable

The 22<sup>nd</sup> Annual PACE Roundtable

## STUDENT FORM

Student Name

Jeremy Drummond**Session 1:**

Topic:

Front end costs

Research Ideas:

- 1) put metrics on different costs of IPD
- 2) allow owner to have numbers to see how much is needed at start & how much will be saved

**Session 2:**

Topic:

Engaging Workers

Research Ideas:

- 1) incentives
- 2) recognition

**Session 3:**

Topic:

Owner Scorecard

Research Ideas:

- 1) Owner grades project as it continues
- 2) progress ~~and~~ reports

The 22<sup>nd</sup> Annual PACE Roundtable

## STUDENT FORM

Industry Member:

Mike Arnold

**Key Feedback:***Which research topic is most relevant to industry? What is the scope of the topic?*

- find up front costs of JPD
- finding overall saving of JPD
- put metrics on costs

**Suggested Resources:***What industry contacts are needed? Is the information available?*

- Cost engineer
- Mike Arnold - used JPD
- Ken Lindsey

If you are interested in becoming more involved with the PACE organization, please leave a business card with your name, PACE number on the back.

PLEASE RETURN THIS FORM AT THE REGISTRATION TABLE