

7700 ARLINGTON BLVD.
FALLS CHURCH, VA

TECHNICAL ASSIGNMENT III



CHRISTIE SMITH

CONSTRUCTION MANAGEMENT

2012 CAPSTONE PROJECT

ADVISOR: CRAIG DUBLER

SUBMITTED: 11/16/2011

Executive Summary

Technical Assignment Three is intended to identify areas of the project that are good candidates for research, alternative methods, value engineering, and schedule compression for 7700 Arlington Blvd. The project is made up of three existing structures, the Northwest, Southwest, and Main building, that have a total square footage of 684,651. The Northwest and Southwest buildings are four stories tall and the Main building is two stories tall. This project overall incorporates a variety of complex systems in order to comply with BRAC BP 198. The largest challenge for this project is to complete the job on time and under budget. Raytheon, the prior tenants, will be occupying the structure for the beginning construction mobilization while DHHQ, the future tenants, will be occupying two out of the three buildings during the second phase of construction.

The three **constructability issues** for this project were material procurement, the control system in the Northwest Building, and coordination changes. Each issue resulted in a unique challenge for the project team especially because the schedule was not allowed to change and the impact of the cost had to be minimal. The critical path of the project schedule initially starts with demolition/abatement, and continues through to structure, façade/roof, enclosure milestones, building core/shell infrastructure, elevators, and tenant improvements. Ensuring mild impacts to the tenant improvements is critical for this job because DHHQ needs to occupy the space as soon as possible. A few **schedule acceleration scenarios** were implemented on 7700 Arlington Blvd. and each scenario talks about the issue that occurred, how the project team developed a plan, and how the plan was put into place. Since the project team, owner, subcontractors, architects, and engineers worked together from the very beginning of the job there were minimal **value engineering topics** according to the project manager. The way the project team handled value engineering is discussed as well as a few suggestions that could have been developed. A brief summary of the results of **critical industry issues** from attending the 2011 PACE Roundtable Meeting on November 9, 2011 are discussed as well as potential research topics for my project for the spring semester.

Through the project manager interview and the 2011 PACE Roundtable Meeting four critical problems have been identified. The **problem identification** has helped formulate four different **technical analysis options** for 7700 Arlington Blvd. These areas of analysis include an integrated project delivery approach, a new mechanical system in the Northwest Building, resequencing of certain renovation activities, and creating a short interval production schedule. Each analysis discussed provides insight into possible research topics for the spring semester.

Table of Contents

Executive Summary.....2

Table of Contents.....3

Constructability Challenges.....4

Schedule Acceleration Scenarios.....7

Value Engineering Topics.....9

Critical Industry Issues.....10

Problem Identification & Technical Analysis Options.....14

References.....17

Appendix A: 2011 PACE Roundtable Worksheet.....18

Constructability Challenges

Material Procurement

One of the biggest constructability challenges for 7700 Arlington Blvd. was figuring out what material was needed for initial start-up. Usually for a new building there is time to arrange for different material deliveries to the site, but because this is a renovation project there was minimal time to get the materials on site for project start-up. James G. Davis Construction worked closely with the other subcontractors to formulate a plan from the very beginning as to what was going to be needed.

Because this project was a renovation job and Raytheon, the prior tenants, were still occupying the buildings, it made it that much more difficult to get the materials that were needed to the jobsite for project start-up. One huge hurdle that James G. Davis Construction went through prior to occupying the building was trying to figure out what the existing conditions were. Figure 1 illustrates the type of drawings that they had with this one being pretty decent compared to some others. The reason they had a hard time with the drawings was because they did not know if the existing condition drawings were correct. These buildings were built in the range of the 1950s to the 1980s, so there was a wide range of drawings that had to be sorted out. Since Raytheon was still occupying the building; Davis Construction had limited access as well.

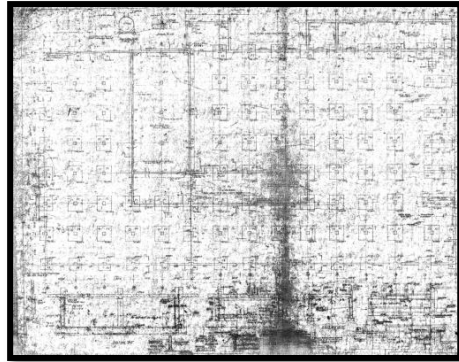


Figure 1: Existing Conditions Drawing
Photo Courtesy of Davis Construction

With only having limited access to the buildings, Davis Construction decided they had to come up with a better solution than just guessing what types of material was needed for the job. They began taking field measurements to recreate the buildings and site in a BIM model. The BIM model was used to fabricate materials in order to get them on site for start-up. Creating the model was probably the best idea prior to 7700 Arlington Blvd. starting because this job has been on the fast track from the very beginning and making one mistake on a big order could really put the project behind. According to the Project Manager, this was the biggest hurdle they had to go through for the entire project because of the time that is invested and all the outlying factors of not knowing what else is in the building that was missed and would cause other headaches down the road.



Figure 2: Progressive Collapse Steel System Storage Area

Photo Courtesy of Davis Construction

By being able to do site measurements and a BIM model prior to the project starting, James G. Davis Construction was able to get their materials on site early enough that they were actually waiting for Raytheon to vacate the building so they could get started. This could not have been done this well without the help and coordination of the subcontractors. Figure 2 shows part of the progressive collapse steel system on site waiting to be installed. There were no issues when it came to storing material on site because of how large the site is.

Control System in the Northwest Building

Since there was limited access prior to project start-up, there was no way of telling what it looked like above the ceilings in each building. This posed a problem in the Northwest Building because the control system for the mechanical system was supposed to remain. The image to the right outlines the Northwest Building for reference.



Figure 3: Northwest Building Site Map

Photo Courtesy of Davis Construction

When James G. Davis Construction opened up the ceilings it was a huge mess. There were so many wires that it was pretty impossible to know where all of them went as well as know which wires were for the control system. What ended up happening was that Davis Construction took out the wrong wires unknowingly. The control wires were completely demolished posing a huge hurdle

into the project. It ended up being an honest mistake, but it was a mistake that would cost them. The picture below is an example of what the inside of 7700 Arlington Blvd. looked like once demolition began. This goes to show that because of their limited access early on in the project, it created many coordination and constructability issues throughout the job. The whole reason why the owner wanted to keep the control system in the first place was because the budget is limited.



Figure 4: Ceiling Demolition at 7700 Arlington Blvd.

Photo Courtesy of Davis Construction

In order to overcome this challenge, the project team took responsibility for the matter and was able to negotiate a joint settlement with the owner. The total mistake cost around \$150,000, but at the end of the day the owner will receive a better product. Originally the Southwest and Main Building control systems were tied together, but because of the mistake all three systems will be tied together which in the long run will benefit the owner tremendously. This constructability challenge was a huge learning lesson, but sometimes mistakes can lead to better and different opportunities in order to keep the construction of the project moving.

Coordination Changes

James G. Davis wrote an RFI asking about dunnage for the huge air handling units on the roof. Little did they know that this was going to open a can of worms because the architect and engineer came back



Figure 5: Roof Top Air Handling Units

Photo Courtesy of Davis Construction

saying there was no dunnage in the design as well as the appropriate acoustical requirements. It is great that this issue was caught, but the issue came too late in the project. Not only did a design have to be done, but other trades were impacted immensely in order to keep the job on schedule. The image to the left is one of the air handling units once installed.

The plan was to build the Main Building top down, but because of the change they were forced to re-sequence the construction. Since each air handling unit was right over the core of the building, the tradesmen were forced to work around the perimeter of the building first. The design took about four months to process, so in the mean time the demolition team had to core drill for the progressive collapse steel system starting with the first floor followed by the second floor. They had to repeat this process for each section in order to get the progressive collapse steel system installed for building turnover which took place in August 2011. The other reason for stacking the demolition was because cutting holes in the slab for steel means water would be entering in places that were not wanted. In order to solve both issues at once the progressive collapse steel system would be installed as soon as the core drilling was done for each column. Below are two pictures of a steel column for the progressive collapse steel system being installed into 7700 Arlington Blvd.

This job is unique because there is challenges everyday that the project team has to overcome and they always have to be on their toes in order to keep the job on track. Having the demolition workers move from the first floor to the second and back down to the first floor was inefficient, but it had to be done in order to get the steel installed on time. Ultimately, the building had to be finished in August and there was no way of changing that, so by having everyone on the site work together great outcomes occur. This challenge proved to be a success and at the end of the day was completed on time even with the design changes.



Figure 6: Installation of Progressive Collapse Steel System

Photo Courtesy of Davis Construction

Schedule Acceleration Scenarios

Project Critical Path

The critical path for 7700 Arlington Blvd. is illustrated below in Figure 8. There are seven main activities on the critical path and the job is divided into two phases. One big risk prior to the project starting was the material procurement process because if James G. Davis Construction fell behind on this task, they would already delay the project. This could not happen due to the fast pace schedule requested by the owner. The Northwest and Main Building make up phase one and the Southwest Building is phase two which is shown in the image to the right. In the project manager’s opinion, the critical path originated with material procurement because they were not allowed to go any further without the material they needed for project start-up.



Figure 7: Two Phase Building Sequence
 Photo Courtesy of Davis Construction

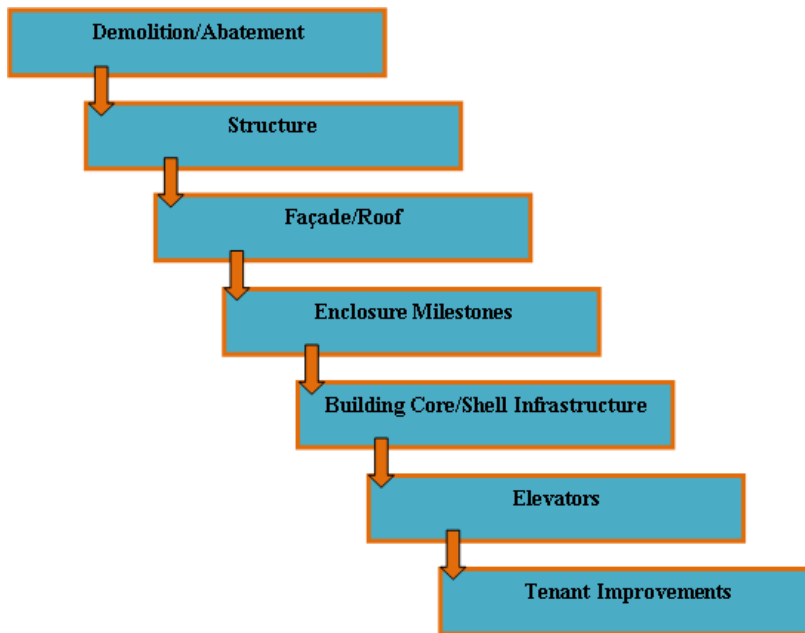


Figure 8: Critical Path for 7700 Arlington Blvd.

The first three activities on the critical path are vital to getting the building enclosed while the last three activities on the critical path are important for building turnover. Granted they are all ultimately significant for building turnover, but by breaking it up, it is a little easier to fully understand the project team’s thought process. Demolition/Abatement started the critical path after material procurement. Each building had different systems to be demolished as well as different areas that needed abatement. The progressive collapse steel system and seismic bracing make up the

bulk of the structure that had to be installed. The biggest risks associated with completing the project on time were installing the steel in every building. The façade could not be installed before the steel system was placed due to the nature of the steel system. One of the biggest ongoing risks associated with completing the project on time is making sure the tenant improvements do not fall behind. Ultimately, if the six items on the critical path fall behind at all, then the tenant team will have to make it up which would be hard to do with the amount of work that must be completed inside the building.

Acceleration Techniques

Through coordination issues and project mishaps different acceleration techniques were utilized on this job. The owner's number one goal on the project was schedule followed by cost, so with having that in mind the general contractor's team had to make a few changes throughout the project. The demolition portion of the project ended up taking longer than expected which impacted the steel installation. In order to accelerate the schedule the project team came up with a plan to do both at the same time. The perimeter

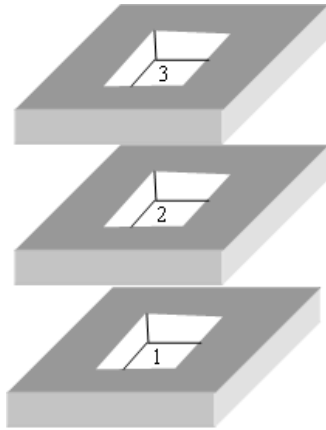


Figure 9: Core Drill Sequencing Diagram

of the building was now scheduled to be demoed first before the core of the building. A twenty foot perimeter was demoed and abatement had to be done as well in order to core drill the holes for the progressive collapse steel system. This constructability issue was also discussed in an earlier section. In order to keep the steel moving the core drilling crew had to drill a hole for the columns in each floor before they moved to the next section. For example in the figure to the left, I have illustrated the basic idea of what the team had to do. They started with hole number one and worked their way up to hole number three and repeated this process for each section so that the steel column could be placed and the schedule could stay on track. By having to remove the core drilling machine and move it from floor to floor instead of keeping it on floor, it obviously had an impact on the cost. The cost information for this technique was not available at the time of communication with the project manager.

Another acceleration technique that James G. Davis Construction utilized was working two shifts due to the fact that this job is on the fast track. The demolition crew, the iron worker's crew, and other tradesmen all worked a double shift in order to get the schedule back up to speed. By creating a plan of such complexity and demand, it poses many safety issues that the project team made sure they were aware of because many workers of different trades were always working in the same area with minimal work space.

One of the most beneficial acceleration techniques developed in the early phase of design was the creation of a BIM model. This not only allowed the project team, owner, designers, and engineers to better understand the building but the whole team was able to design a plan for most of the construction process. The figure to the right shows a Navisworks model of 7700 Arlington Blvd. The progressive collapse steel system as well as the façade was coordinated greatly through the use of this program. Without 4D modeling, the schedule for this project could have been a lot longer than necessary.



Figure 10: Navisworks Model
Photo Courtesy of Davis Construction

Overall, there were a few great plans used on 7700 Arlington Blvd. in order to accelerate the schedule. At times these plans were used due to the fact that the schedule was falling behind, but that is the nature of a renovation project. It is hard to predict what the demolition crew will find and even if there is float built into this activity, it may not be enough which is why good project management teams are able to find a technique that will work and fix the problem.

Value Engineering Topics

After speaking with the senior project manager for this job, there was very limited value engineering done on this project. In her opinion, the little that was done made no true impact on the job due to the nature of the project. 7700 Arlington Blvd. is an extremely fast pace job for the size of it with construction set for about 20 months. Therefore, this project missed the opportunity to implement value engineering techniques that could have potentially helped with the overall time and money.

There are many factors that play into why value engineering was not utilized with the main reason being that this project was stripped to its bare bones from the very beginning. There was little room to make improvements with the budget that was allocated. The most important goal for the owner was making sure the project was done on time due to BRAC BP 198. James G. Davis Construction was included from the very beginning of the project which resulted in constant communication with the owner and designer. The design that was created incorporated items that would have been value engineered later in the project, but because of a collaborative work environment the design was created as lean as possible.

Since this job is a renovation, there were a few items that remained in the building. The biggest item that everyone decided to keep was the existing mechanical system in the Northwest Building. There would be minimal changes, but for the most part kept the same. Since the issue with the control wires, discussed previously, happened there has been more changes overall. One idea behind this headache would be to value engineer a different system and compare the advantages and disadvantages to the existing mechanical system to see if it would have been worth installing a new system right from the beginning. Another item that the general contractor recommended to the owner in order to save money was exchanging custom elevator cabs to standard elevator cabs. This did not save the owner a great deal of money, but it is one example where a form of value engineering was used on this project.

Overall, I believe that James G. Davis Construction worked well with everyone who helped out with the design and coordination of this project that there was no real need to implement value engineering. Value engineering takes time and that is the one item there was none of for this project. Through the constant coordination and communication with others, Davis Construction was able to bid this job under budget for the owner which proves that working as a team from the beginning is extremely beneficial and value engineering was incorporated throughout the whole process of design.

Critical Industry Issues

**Reference Appendix A for the 2011 PACE Roundtable Worksheet*

The 2011 PACE Roundtable Meeting was held on November 9th, 2011 at The Penn State Conference Center. The meeting is an open forum discussion in which key topics selected by the advisory board are discussed by students and industry practitioners. The agenda for the meeting included two break-out sessions in the morning followed by two industry panels and a focus group in the afternoon. The morning break-out session topics are outlined below.

Break-Out Session I

1. Energy Management Services
2. Assembling/Procuring an Integrated Team
3. BIM Services for the Owner – The Role of the Design and Construction Professional

Break-Out Session II

1. Learning Systems for Training a Sustainable Workforce
2. Integrated Decisions for High Performance Retrofit Projects
3. Strategies and Opportunities for taking BIM into the Field

The afternoon panel discussions were about differentiation in a down economy and hands-on learning in design and construction. All of these sessions were useful for finding interesting research topics for thesis. Since there was a lot of information to gather and understand, the last part of the day was to sit with an industry member and discuss the different research ideas we gathered from the earlier sessions. This proved to be helpful in many ways because there were at maximum three students to an industry member and we received a “real-world” perspective on the research we were interested in.

The PACE Roundtable Meeting was a great way to get industry opinions on what companies are trying to do to advance themselves for the future. It was a rewarding day and it ended up being extremely educational for research topics that relate to 7700 Arlington Blvd. The two sessions that I attended in the morning were assembling/procuring an integrated team and strategies and opportunities for taking BIM into the field. I chose to go to the first break-out session because I find that it would be valuable to be able to work as a true IPD team on projects, especially a renovation project. As for the second break-out session, I chose to pursue BIM because it was used on 7700 Arlington Blvd. and it is interesting to hear what other companies are doing to implement BIM not only in the office, but out in the field with the superintendents, workers, and other invested project employees. My industry contact from this section as well as every other section is Bill Moyer from James G. Davis Construction Corporation.

Break-Out Session I – Assembling/Procuring an Integrated Team

Before Break-Out Session I is discussed it is vital to understand the meaning of IPD. According to ipd-ca.net, Integrated Project Delivery is, “A project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize

efficiency through all phases of design, fabrication, and construction. In all cases, integrated projects are uniquely distinguished by highly effective collaboration among the owner, the prime designer, and the prime constructor, commencing at early design and continuing through to project handover.” (McGraw_Hill)

The main conclusion I got out of the break-out session and what surprised me the most was that trust is the main issue when it comes to forming an IPD team. This formed when we discussed what the barriers were when assembling/procuring an integrated team. Trust is the main issue because being able to coordinate and make decisions amongst many different companies is difficult in the building industry. A Contractor and Subcontractors can say they will work together from the beginning of the project, but as soon as something goes wrong they separate forming their own conclusions instead of working together and sharing the risk and reward. As you can see, forming an integrated team is widely a behavioral issue and it is something that needs to be overcome because the reward for being on a team can greatly outweigh working separately on a project. Overall, the main idea for a project is to give the client the best product as humanly possible and by making decisions early on in the project can greatly benefit the client as well as working together because more ideas and solutions will flow between everyone.

Another issue that was discussed during the session was that it is hard to get certain owners on board with the IPD concept because they do not see the benefit for them. The outcome of this discussion resulted in a few intriguing points with one of them being that owners are not educated enough to fully accept the IPD method. The owners worry that they will be paying a premium for the subcontractors that have experience with IPD and certain construction methods. The idea that was brought up in the group was that in order to start implementing IPD it would be a good idea to find the sophisticated owners where they have an invested interest in the whole big picture. By targeting these kinds of owners, hopefully others will see the full benefit of having an integrated team. One other intriguing point that came about from the conversation was the idea that IPD cannot be done alone. For example, when Building Information Modeling began in the industry, contractors were able to produce models in house without the help of others whereas with employing IPD you have to rely on everyone else in the industry for this to be successful. IPD in my opinion is more of an abstract concept because there is not one answer that can solve the problem or at least no one believes there is from the conversation in the break-out session.

This idea of assembling an integrated team is very stimulating and there are a few different aspects I want to look at for my research. One research idea I had was to break down two different contract documents, one for a project with an integrated project team, and one contract for a project with a design build team, and analyze the gaps and differences between the two. I would like to breakdown and try to figure out where that trust can be implemented into the contract documents and phase of project to make IPD successful. The other research ideas I had were figuring out how to effectively communicate with others on how to use IPD through different forms of education. In addition to this I want to look at how to ensure a subcontractor who helps with initial design documentation for a job will be on that project the entire time. Meaning they would not have to bid the job after they have already helped with the initial design concepts. Both of these ideas relate directly with my thesis building and I hope to be able to find some solutions, so that in the future IPD will be easier to implement.

Overall, the first session was eye-opening because we learn about these kinds of methods all the time, but to actually hear the industry members talk about how difficult they are to implement is interesting. I enjoyed that everyone was brutally honest and I do truly believe it is going to be difficult to implement IPD to its fullest extent, but hopefully over time different strategies will be employed were trust will not be a worry on projects.

Break-Out Session II – Strategies and Opportunities for taking BIM into the field

The beginning of this session began with discussing what industry members were using in the office and out in the field. The general consensus that I got from everyone was that they all used 3D Coordination and 4D Modeling and were starting to implement the Apple IPADs into the field for punchlists, quality control, and a few other means and methods. This session was completely different than the first session that I attended because this session mainly discussed what was out in the field whereas the IPD session looked more into analyzing what it was and how it needs to be changed. The good aspect about BIM is that it is extremely prevalent in the industry and the need now is looking at how to take the model into the field and use it effectively. One of the biggest issues with building a model is ensuring its accuracy. Anybody can throw some rooms and systems into a model, but the biggest question is how is it done effectively so that the owner could use the model years down the road when he/she wants to do a renovation, fix an issue, etc.? I gathered from the session that mostly every company is using an Apple IPAD on their construction sites. One idea that was mentioned and I believe was being used on a site was implementing a portal for the owner to track everything that is going on with the project. Some items that they can track include when deliveries will be arriving as well as being able to open the latest models of the building. Granted this does not have to be done on an IPAD but it is one possibility.



Figure 11: Apple IPAD in the Field

Another way companies are using the IPAD in the field is for coordination. They can upload the drawings to the IPAD and go out into the field to figure out different issues and track them via the IPAD. This is useful because the IPAD provides an immediate solution to tracking and coordinating with the field staff. I felt there were more questions asked than answered within this discussion and there was more of a debate between different industry members on the right way of utilizing these types of pieces of technology. I enjoyed listening to the industry members because it was a good way to see where I could focus my research in order to answer some of their burning questions.

I thought the most surprising and interesting way a few of the industry members were utilizing 3D modeling was through communicating safety concerns for different aspects of their projects. For example, they would show how to excavate a certain area properly and safely through the use of 3D modeling. I believe this is very effective because safety is by far the number one concern on construction sites and more time should be placed on coordinating the logistics to ensure that no one will get hurt.

After listening to what everyone had to say about different opportunities for taking BIM into the field, I formulated a few ideas on my own. The different areas I want to look into include implementing augmented reality into interior spaces to further communicate design details to the client and I would also like to look into what the labor workers would like to see out in the field because ultimately they are the ones installing the work and if I can make their lives easier with some form of technology I want to do it. Both of these ideas work well for 7700 Arlington Blvd. because understanding all the finishes that are going into individual spaces is challenging. Overall it was a good session and I was able to create research ideas that will hopefully help projects in the future.

Afternoon Panel Discussions

The first panel discussion included four industry members and their views on the economy and how to differentiate oneself in a down economy. The main point that I got out of this discussion was that the economy is never going to go back to what it was and that the new economy is going to be about working smarter. This means that different companies could branch out into specialty markets or implement different construction methods on projects that others do not, and do jobs in industries that will never fade such as healthcare. The panel broke it down that when looking for a job, everyone in Architectural Engineering comes out with the same type of education, but doing the extracurricular activities and differentiating yourself from another person is vital in this industry. Some research ideas that came about from this discussion are finding out what exactly are the differentiating factors that set someone apart from another. Another idea would be to take a look at different financial statements from over the years and try to formulate what could happen in the future to the economy based on these statements. The second panel just discussed different individuals' experiences in the field and their thoughts on how they look at the industry with having that experience.

The meeting was educationally in many ways and overall provided me with many different research ideas for my thesis building. It is always nice when an industry member brings you back down to reality with the different ideas that formulate from the sessions and discussions that were talked about at the meeting. Hopefully the spring semester will prove to be successful in its entirety with all the research that will be done for 7700 Arlington Blvd.

Problem Identification and Technical Analysis Options

Technical Analysis Method #1: Integrated Project Delivery Approach

Problem: Material procurement was a huge challenge for this project and it involved a lot of time and money to ensure the success of materials on site prior to job start-up. The owner invested money up front in order to purchase and ensure certain materials such as the progressive collapse steel system. Another problem with the initial design phase of this project was that the subcontractors that invested their time and money were not guaranteed that they would win the bid to finish out the entire project. In my opinion, this poses a huge business issue because as a general contractor you have to make the subcontractors submit a bid and if they are not awarded the bid then there was no real benefit for them to help you from the beginning. Granted more times than not, the subcontractor that has helped in the design phase will be awarded a bid, but it is still not 100% guaranteed. The one subcontractor that invested a lot of their time and money in the design phase was the steel contractor who helped with the complex progressive collapse steel system.

Analysis: The research that I would like to explore for this problem is figuring out how to implement an integrated project delivery approach from the very beginning of a project effectively. I want to be able to create a process map of a traditional design-bid-build project and an integrated project to show the difference between coordination and communication levels throughout the entire project lifetime. This is going to involve an in-depth analysis of two different types of contracts in order to find certain gaps within the language to show what needs to be changed. It is also going to involve communicating with the general contractor's field staff and office staff in addition to the steel subcontractor. I would like to create a process that is efficient and beneficial to all parties involved and I believe using IPD on a job like 7700 Arlington Blvd. would be valuable. Also, I would like to figure out a way to guarantee that if the subcontractor is putting forth money to help design certain systems for the building that they will be a part of the entire project through the use of IPD.

Technical Analysis Method #2: New Mechanical System in the Northwest Building

Problem: Since this building is a renovation, some of the systems were to remain due to the owner's budget. The Northwest Building was to keep the control system and mechanical system that already existed with minor improvements. Due to the unforeseen ceiling conditions, a mistake was made by the general contractor resulting in time and money lost. In the end, the owner will benefit greatly from the lost because a whole new control system will be put in place and tied in with the other two buildings. This was a huge constructability challenge, as discussed prior, and it was a learning lesson because it is not always better to skimp in areas that could potentially result in big changes.

Analysis: This problem leads me into many different areas of research with the main research focusing on implementing the same SW Building mechanical system into the NW Building from the beginning of the project. The reason I think this would be beneficial is due to the fact that these buildings are quite old and Raytheon still occupied the space up until the very last moment. There was no way of telling that the ceiling was going to look like spaghetti once it was opened. Since the Southwest Building and Northwest Building are identical I would like to perform a cost analysis on what the difference would be if the same mechanical system from the Southwest Building was installed in the Northwest Building. I would also

like to create a schedule analysis showing the time it would take to completely demo the space and install the mechanical system. This then can be compared to the schedule of what actually happened on the site due to the mistake as well as the schedule of what should have happened if there was no mistake on the project. There are many areas of research that can be performed for the mechanical and control systems which should provide a unique analysis in the end. In addition to the mechanical system being implemented into the Northwest Building, I would also like to calculate the reinforcement that will be necessary to install such big units on the roof. I will be able to incorporate a cost and schedule analysis for this aspect of the research as well. Contact with the mechanical subcontractor would help provide some insight on the feasibility of the analysis as well as feedback from the general contractor of the cost and schedule impact implementing a new mechanical system would create.

Technical Analysis Method #3: Resequencing Renovation Activities

Problem: The time allotted for the demolition was not enough and ended up impacting the structural aspect of 7700 Arlington Blvd. The project team had to create a new plan as to how they were going to keep the schedule on time as well as get the demolition and structural systems installed. The plan that was created ended up being extremely successful but costly because most crews worked double shifts in order to get the work completed. The big issue here which was discussed earlier is safety on the jobsite. This project is not that small, so in my opinion different trades should not have to be on top of one another in order to finish work.

Analysis: The analysis I would like to perform on this issue is figuring out a plan that could have been implemented from the very beginning in the schedule to avoid a situation where many trades would be working in one area. I would like to utilize the BIM model that was created for this project to show a different way to sequence the work. Since safety is the number one most important part on a jobsite I would also like to analyze the safety impacts that could happen through the use of both plans. The research done for this issue is more of a case study of what actually happened on the jobsite and what could have been done to prevent such issues. Eliminating the double shift will be one aspect of the plan with productivity being another because having the core drilling crew move from floor to floor instead of completing one floor at a time is wasteful. Navisworks and Microsoft Project will be the two main programs that will be used for this analysis and my primary contacts will be with the project management team.

Technical Analysis Method #4: Creating a Short Interval Production Schedule

Problem: There are many areas throughout the project from the initial design phase to construction that has created challenges for the design team. The problem is that coordination is a tremendous part of the day to day task and 7700 Arlington Blvd. has a pretty complex schedule. There seems to be many areas of the job that have repetitive work, but got thrown off schedule due to the critical path. Always having these issues on a project is not always good because it could ultimately push back the finish date and increase costs.

Analysis: The area of study I want to look into is creating a short interval production schedule for the repetitive activities on the jobsite. By creating this type of schedule, the project team can put their focus more so on the complex systems that have to be installed and the coordination with the tenant side of

work. The result I would like to get out of this is a reduction of the overall project schedule. In addition to that, I would like to relieve some of the extra planning that has happened due to coordination issues and unforeseen activities. To do my research I will analyze the current schedule and communicate with the project team as to what they think the most repetitive activities would be since they have been on the jobsite for awhile now. I will also divide the building into different areas in order to apply the SIPS method and then analyze the results I get. I think this method of research will be very intriguing and beneficial for understanding the commonalities on the job.

References

- CIC Research Program at Penn State. (2010) "*BIM Project Execution Planning Guide.*" Version 2.0.
- Elert, Glenn. (2004) "*Density of Steel.*" Accessed: 12 October 2011.
<<http://hypertextbook.com/facts/2004/KarenSutherland.shtml>>.
- GBA Associates LP. (2011) "*7700 Arlington Blvd.*" Accessed: 22 September 2011.
<<http://7700arlingtonblvd.com/dhhq.html>>.
- McGraw_Hill Construction. (2011) "Integrated Project Delivery." Accessed: 11 November 2011.
<<http://www.ipd-ca.net/>>
- Raytheon Company. (2011) "*Raytheon Company: Customer Success is Our Mission.*" Accessed: 22 September 2011. <<http://www.raytheon.com/ourcompany/>>.
- Reed Construction Data. (2011) "*RS Means Costworks Online Construction Cost Data.*" Accessed: 22 September 2011. <<https://www.meanscostworks.com/>>.
- RSMeans. (2010) "*RS Means Facilities Construction Cost Data, 2011.*" 26th Annual Edition.
- U.S. Green Building Council. (2011) "*U.S. Green Building Council.*" Accessed: 17 October 2011.
<<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220>>.

Appendix A

2011 PACE Roundtable Worksheet

Student Name Christie Smith

Session #1

Topic: Assembling / procuring an integrated team

Research Ideas:

- (1) Breaking down the contract documents to analyze where the gaps are in order to implement IPD fully. (Comparing IPP contract w/ Design Build contract)
- (2) How do you effectively communicate w/ others (i.e. trust) to use IPD? Also, how do you ensure that the contractors who help with initial designs help w/ the entire project and not have to bid?

Session #2

Topic: Strategies + opportunities for taking BIM into the field

Research Ideas:

- (1) Implementing augmented reality / 4D modeling into the field to market and explain ideas to others especially the owner.
- (2) What do labor workers want to see w/ 3D modeling, etc in order to make their job easier? One idea is taking 2D drawings and upload them to an iPad & then have the opportunity to click on say a door and a 3D detail would pop up w/ installation instructions and images readily available.

Industry Panel: Differentiation in a Down Economy

Research Ideas:

- (1) What exactly are the differentiating factors that set someone apart from another?
- (2) Looking at different financial statements from over the years to try to formulate what could happen in the future to the economy based on these statements.

Industry Member Discussion

Key Feedback:

Which research topic is most relevant to industry? What is the scope of the topic?

- Bill Moyer thought my research ideas were very interesting especially when they are related to my thesis building. ~~the then~~
- One of the most relevant research topics is the utilization of the Apple IPAD in the field.
- Also, comparing two contracts to try and figure a way to more easily implement IPP was pretty relevant to the industry.
- I am going to need two different contracts of similar project type to do a comparison.
- I will also need to communicate to different companies to ask questions for both topics of research.
- I might also need to borrow an IPAD to see if my research ideas will work.

Suggested Resources:

What industry contacts are needed? Is the information available?

- Bill Moyer from James G. Davis Construction Corporation is my main contact for all the research ideas I have.
- I will also be speaking to the subcontractors on my thesis building to gather information to do my research.