Technical Assignment 3

New Classroom Building

Blacksburg, VA

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Construction Management

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Executive Summary

The Technical Report III takes a closer look at any project challenges and opportunities within the construction industry as well as the New Classroom Building. This Virginia Tech building is intended primarily for educational purposes. The project will result in a three-story structure containing 73,400 gross square feet. The New Classroom Building will mostly consist of classrooms and laboratories. At a total of $42,650,000, this project is scheduled for construction from January 26th, 2015 to early August 2016. The building will subsequently be available for occupation before the fall 2016 semester. Lastly, the New Classroom Building is designed to obtain a LEED Silver Certification.

W.M. Jordan is the construction manager for the New Classroom Building. They were hired during the design of the project. This allowed W.M. Jordan to provide their construction experience and knowledge to any design questions. They also provided cost estimations during preconstruction. In this project, the client needs a quality product that is delivered on time and under budget. Thus, W.M. Jordan may have to alter the phasing of construction in order to meet these needs. A transcript of my interview with a project manager from W.M. Jordan is located in the Appendix of this report.

Part of the design process for the project was value engineering. This was implemented to meet the owner's needs as described above. Several cases of value engineering during the schematic and conceptual design phases are explained within this report. They will ultimately show that the priority between cost, scheduling, and quality varies between cases, and the final decision goes to the owner.

A large portion of this report deals with the PACE Roundtable Meeting that was held on November 3rd, 2015. The purpose of this meeting was to bring together members of the construction industry and AE students in order to discuss major topics within the industry. These discussions included any challenges and opportunities in the construction process as well as advice for students that are about to start a career in the industry. This technical report contains a summary for each discussion I attended, in addition to any potential contacts and research ideas.

The last portion of this report focuses on the evaluation process of a project. Two major systems used to evaluate a project are through Building Information Modeling and the LEED Point System. This tech report contains the BIM use list and Level 1 Process Map that I believe would work best for the project. I also discuss the actual BIM procedures for the New Classroom Building. Lastly, the LEED Point System for the project is located in this report. It is important that Virginia Tech sends the right message to all faculty, students, and visitors. As a university that aims to give their students an education that will create a better future, it is vital that their facilities reflect the same message. The point system will show that Virginia Tech cares about the health of their campus, students, and facilities. It also displays how the design of the project will help reach the owner's goal of LEED Silver Certification.

Project Management Services

The construction manager on the New Classroom Building is W.M. Jordan, and they were hired during the schematic design phase of the project. Due to the timing of the hire, W.M. Jordan was able to give their impute from a construction standpoint on any design questions. This is a major reason why Virginia Tech uses CM at Risk for most of their projects. Also, W.M. Jordan's preconstruction services included estimates as well as other budgetary information. The construction cost for the project began at $35 million and was cut down to around $23 million. However, that budget was deemed inadequate during value management phases and was eventually increased to $30.5 million. For the owner, Virginia Tech, there isn't one specific challenge that requires the majority of project management. The project cost, phasing, and quality are all of high importance. The project needs to be finished before the end of the summer in order to prepare for the fall semester. The quality of the building cannot suffer because it will only have a negative impact on the educational purposes of the building. Lastly, Virginia Tech has a responsibility to properly allocate their budget to all aspects of the university. Thus, the budget for the project cannot inflate and absorb more of the universities resources. A major focus for the schedule was to have extra days to accommodate any unforeseen challenges; such as weather, underground utilities, and difficult subcontractors. There have not been a lot of design changes; which explains the low number of RFIs for the project. One challenge during construction has been the difficulty of removing rock during excavation. This caused the removal of 2,000ft of underground sanitary piping to go from 2 to 5 months. A bypass pump system was used in the meantime in order to keep the university utilities functioning properly. Another construction challenge occurred during the installation of the concrete shear walls. The installation was taking longer than expected and therefore delaying the structural steel. In order to make up for this delay the amount of man-hours a day was increased. There were now two shifts, one during the day and one at night. Also, the phasing of the project was altered. The structural steel was placed in the middle of the building while the shear walls were installed on the west and east sides. In conclusion, W.M. Jordan has to juggle between cost, time, and quality in order to deliver a product that best meets Virginia Tech's needs.

Value Engineering

The value engineering was also used to give the client a final product that best meets their needs. In this case the value engineering process looked at ways to improve the cost, scheduling, and quality of the project. Value engineering took place during the four phases of pre-construction: conceptual design, schematic design, design development, and construction drawing. An example of a decision that was made during the conceptual design phase was the mechanical system. The original idea was to use an air distribution system underneath the floor. However, after comparing the cost with other mechanical systems, the design was changed to a VAV air system located in the ceiling. This decision ultimately saved about $1 million. During the schematic design phase, the budget for the project was cut to $23 million. Thus, there needed to be changes so that the design reflected the lower budget. As a result, the number of vertical folding partitions, located in the ceiling, was lowered. These expensive partitions were intended to separate large rooms into multiple classrooms/working spaces. The original design contained 6 partitions and was reduced to 2; which amounted to $500,000 in savings. However, not all decisions were made based on cost. During the schematic design phase, the project team debated whether one of the building's two elevators should be removed. The change would have saved $100,000, but in this case quality was valued over cost. The owner would not accept only one elevator for the entire building. Therefore, all project decisions are made with the owner's best interests in mind.

Critical Industry Issues – PACE

The first PACE Roundtable Meeting that I attended had the following topic: Distributed Leadership vs. Centralized Decisions. The conversation began with members of the discussion giving their interpretation of what distributed leadership means. The take away from this is that distributed leadership occurs when all the representatives from the different parties within the project, each with a distinct project role, come together to share the risk. In such a case, trust and accountability are vital to the success of the project. It is difficult to share the risk when there is no trust. There's also the challenge of uniting the teams yet holding each team responsible for their role. One way to hold each team responsible is by clearly defining each team's role prior to the start of the project. Thus, the contracts of a project become very important because they legally specify not only what each team's role is, but also who holds the right to a final decision. The conversation then transitioned to ways a leader can improve the work of underperforming teams. Two possibilities discussed were more training and the use of trust building exercises early on. One claim that surprised me during the discussion was that leaders do not always make decisions. Sometimes being a good leader means keeping quality communication more than making orders. I hadn't given this much thought but once it was brought up I found myself strongly agreeing with the claim. With regards to the New Classroom Building, Virginia Tech as the owner has the final decision. However, the project manager has been designated as the representative of the owner and their role was defined at the preconstruction meeting. The research ideas drawn from this discussion can be found in the Appendix of this report.

The second PACE Roundtable Meeting that I attended had the following topic: Driving Collaboration into the Field. In the beginning of the conversation someone suggested using a survey for both the office and the field in order to get an understanding of the collaboration. It's important to understand the project from multiple point of views; the A/E and owner vs. the contractor and subcontractors. A major point that kept coming up during the discussion was in order to successfully collaborate; all parties must be working towards the same goals. This then led to the emphasis of the following: hold meetings with the foreman, make sure all crew members know the short term goals, and make sure each trade understands the importance of all other trades. This emphasis on checking the subcontractor's goals came as a surprise to me. As someone with little experience in the field I figured everybody showed up to the project with the intention of making the best product. I didn't take into account that some parties can tend to do what is easiest for them, regardless of the overall project outcome. Lastly, the discussion cleared up the difference between coordination and collaboration. Collaboration is when each team member knows what their role is and why they need to do it. This discussion ultimately applies to every project and thus should be taken into consideration for the New Classroom Building. There must be collaboration between the subcontractors, construction manager, architect/engineer, and owner. Thus, W.M. Jordan must make sure that all of their subcontractors understand the importance of the other trades' work and how it can impact the work of their trade. All research ideas taken from this discussion can be found in the appendix of this report.

The following contacts may be used to aid any future research based on ideas taken from the PACE Roundtable Meeting:

Patrick Laninger (Barton Malow): patrick.laninger@bartonmalow.com

Dr. Somayeh Asadi (Penn State University): asadi@engr.psu.edu

John Bechtel (OPP): jrb115@psu.edu

Feedback from PACE Industry Roundtable

After the discussion session at the PACE Roundtable Meeting, we broke out into groups with individual industry members. During which I spoke to Patrick Laninger from Barton Malow about some of the research ideas I had from the PACE discussions and my specific project. Patrick then expressed his opinion on the topics, his experience with his own thesis project, and made suggestions that pertained to my specific building. The research topic we discussed was to analyze the changes made in the procurement, delivery, and installation process of the Hokie Stone throughout several projects at Virginia Tech. We also talked about changing all curtain walls to another material, and the impact it would have on the mechanical and structural systems. All notes taken during the discussion can be found in the appendix of this report.

BIM Use Evaluation

Listed below are the BIM uses I have suggested for the different phases of this project. As shown below, I have selected Existing Conditions Modeling, Cost Estimation, Phase Planning, 3D Coordination, Site Utilization Planning, and Maintenance Scheduling. The Existing Conditions Modeling begins during the planning phase and is used all the way through operation. It is an extremely beneficial model because it maps out the conditions of the site before, during, and after construction. This is an important piece of information for the New Classroom Building because it is located on the Virginia Tech Campus. Thus, there are many site utilities that supply other buildings and areas on campus. Any mistakes with the handling of these utilities could have an impact on multiple buildings. The Cost Estimation also takes place during all four phases of the project. I selected this use because cost is one of the project priorities for the owner. It is also helpful to give all parties access to the estimation so that the entire team understands the goal of staying under budget. The next use selected was phase planning, which is implemented at the beginning of the project and used until the end of construction. I selected this use because the schedule is also important to the owner. With this tool, you can apply a 3D model to the schedule and map out a 4D plan of how to not only work within the building footprint but around the entire site. A similar model, 3D Coordination, will be used during design and construction to help detect any potential issues with the different trades. This model can use clash detection to eliminate any installation problems. Site Utilization Planning is another great use for the schedule. It will allow a fluid flow of work around the site and mitigate any hazards/safety issues. Lastly, I chose the Maintenance Scheduling use because it will help the owner get their moneys worth out of the building. This building is intended to have a 100-year service life, which will not be realistic unless the building is taken care of during operation.

The actual BIM model for the project, created in Revit, is a set of coordination drawings. This model has been developed by the architect then given to the contractor so that they may update the drawings for construction. All construction changes must also be made in the BIM model within 15 days of the change. The Architect’s model is used as a base model, then all the trades add their information to create one fully integrated model. Thus, the model includes architectural work, plumbing work, HVAC work, electrical work, fire protection system information, and structural work. The contractor uses clash detection to eliminate any trade conflicts on the project. The architect will make sure that all changes made to the BIM model are implemented up to the standard scope, but will not actually check for the accuracy of the trade information.

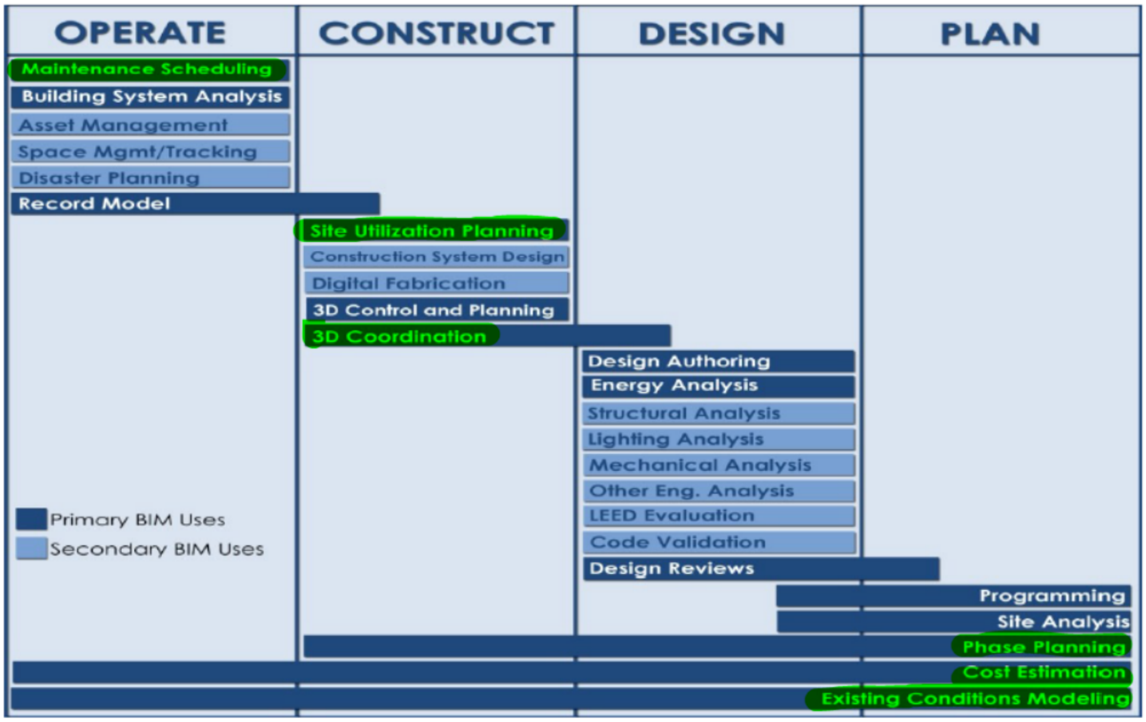

Image Source: PSU BIM Project Execution Planning Guide V2.1

Sustainability Implementation

Pictured below is the actual LEED Point System for the New Classroom Building. It clearly shows that the sustainability system for this project meets the owner's goal of obtaining a LEED Silver Certification. Therefore, the overall point system is appropriate for this project because it displays the conscious effort to create a sustainable product without affecting the budget. The most important categories contained the most points. Energy and Atmosphere had the most points, which is vital because an energy efficient building can reduce the operational cost and thus meets one of the owner's priorities. Next is Sustainable Site; this project cannot damage the environment of the campus. Indoor Environmental Quality is third, which makes sense because the students will not be able to gain the full educational benefits of class if they are in a poor working environment. Close behind is Materials and Resources category, the use of Hokie Stone from local quarries reduces the amount of resources needed to transport the material to the site. The point system finishes with Water Efficiency, Innovation and Design Process, and Regional Priority Credits.

LEED 2009 for New Construction and Major Renovations

Project Checklist

Va Tech New Classroom Building

Y	?	N			
15	5	4	**Sustainable Sites**	Possible Points:	26
Y			Prereq 1	Construction Activity Pollution Prevention	
	1		Credit 1	Site Selection	1
3	2		Credit 2	Development Density and Community Connectivity	5
		1	Credit 3	Brownfield Redevelopment	1
4	2		Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
		1	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
		1	Credit 6.2	Stormwater Design—Quality Control	1
1			Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
		1	Credit 8	Light Pollution Reduction	1

6	0	2	**Water Efficiency**	Possible Points:	10
Y			Prereq 1	Water Use Reduction—20% Reduction	
4			Credit 1	Water Efficient Landscaping	2 to 4
		2	Credit 2	Innovative Wastewater Technologies	2
2			Credit 3	Water Use Reduction	2 to 4

9	0	6	**Energy and Atmosphere**	Possible Points:	35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	0
Y			Prereq 3	Fundamental Refrigerant Management	
5			Credit 1	Optimize Energy Performance	1 to 19
		1	Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
		3	Credit 5	Measurement and Verification	3
		2	Credit 6	Green Power	2

7	0	4	**Materials and Resources**	Possible Points:	14
Y			Prereq 1	Storage and Collection of Recyclables	0
		1	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
		1	Credit 3	Materials Reuse	1 to 2

Y	?	N			
			Materials and Resources, Continued		
2			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
		1	Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1

13	0	2	**Indoor Environmental Quality**	Possible Points:	15
Y			Prereq 1	Minimum Indoor Air Quality Performance	0
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	0
1			Credit 1	Outdoor Air Delivery Monitoring	1
		1	Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
1			Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
		1	Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

2	1	3	**Innovation and Design Process**	Possible Points:	6
1			Credit 1.1	Innovation in Design: Site Plantings as a learning Tool	1
	1		Credit 1.2	Innovation in Design: Building as a Learning Tool?	1
		1	Credit 1.3	Innovation in Design: Specific Title	1
		1	Credit 1.4	Innovation in Design: Specific Title	1
		1	Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

4	0	0	**Regional Priority Credits**	Possible Points:	4
1			Credit 1.1	Regional Priority: EA c1	1
1			Credit 1.2	Regional Priority: SS c4.1	1
1			Credit 1.3	Regional Priority: SS c6.1	1
1			Credit 1.4	Regional Priority: WE c3	1

56	6	21	**Total**	Possible Points:	110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Appendix

Project Manager Interview

Q: What project management services, specifically preconstruction, is W.M. Jordan providing?

A: We were hired during the schematic design phase of the project. We provided estimates and budgetary information to the owner. The project budget was originally $35 million but was cut down $23-24 million. However, through the phases of value management the budget was increased back towards the original number. The final budget was $30.5 million.

Q: What is the biggest challenge for the owner? Is it cost, schedule, or quality?

A: I can’t say that there is really one of those that is held higher than the other. They are all very important to the owner.

Q: Are there any schedule concerns for the project, and how do you deal with it?

A: There are a lot of curveballs that are thrown at you with the schedule. You could have problems with the weather, underground utilities, and bad subcontractors. The best way to prepare for them is to build days into the schedule specifically for these problems.

Q: Have there been a lot of design changes?

A: No there have not been a lot of design changes. There have only been about 100 RFIs so far, so this shows that there were no major changes to the design.

Q: What are some construction challenges that you’ve experienced with this project?

A: There have been a lot of problems with excavating the rock for this project. The removal of 2,000ft of underground sanitary piping went from two months to five months in the schedule. In the meantime a bypass pump system was used to keep the campus utilities working. There was also a problem with the installation of the concrete shear walls. They were not being installed fast enough on the far east and far west sides of the building. This would cause a delay to the structural steel, which is put in place after the concrete shear walls go up. In order to make up for this time, the structural steel located in the middle of the building was placed at the same time as the shear wall went up on the east and west side. Then the structural steel on the east and west side was placed after the shear was were installed.

Q: Do most Virginia Tech projects work under the CM at Risk delivery?

A: A lot of Virginia Tech projects use the CM at Risk delivery. Virginia Tech likes to use it because it allows the architect and engineer to get information from the construction manager during design. There is a fee for the preconstruction services but it is relatively small.

Q: What are some examples of value engineering used on this project?

A: Value engineering is used in the four phases of the project design. One example of value engineering that took place during the conceptual design phase is the removal of an under floor air distribution system. When it was evaluated for cost versus the traditional overhead VAV air system, the traditional system appeared to be the better choice. This change saved $1 million. During the schematic design phase, when VCOM initially slashed the overall budget, there were six new vertical folding partitions. These partitions are expensive and come down from the ceiling. We saved $500,000 by taking out 4 of the 6 partitions.

Q: Were there any cases of value engineering where the change was not implemented?

A: Yes, during the schematic design phase, the building started with two elevators. It was determined that getting rid of one of the elevators would save $100,000. But in the end the users were against it. The owner would not accept 1 elevator.

The 24th Annual PACE Roundtable

STUDENT FORM

Student Name Michael Devaney

Session 1: Topic: Distributed Leadership vs. Centralized Decisions

Research Ideas:

1) Compare the decision making process between projects. When are decisions Made and why? What decision Making frameworks are there between distributed vs. Centralized.

2) See what goals each member in the project team has at the beginning and end of the project.

Session 2: Topic: Driving Collaboration into the Field

Research Ideas:

1) Are there certain size projects where technology doesn't work.

2) How to use past projects to evaluate for future projects.

Session 3: Topic: __________

Research Ideas:

1)

2)

24

STUDENT FORM

Industry Member: Patrick Laninger

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

How do clients that need similar projects evaluate the project and perfect the process. My project deals with Virginia Tech which has a Hokie stone facade on all of its buildings. How have they altered and perfected thee stone mason process. Breadth Ideas: Use a different material for the curtainwall, one with more insulation, test mechanical difference, check structural change.

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

- Virginia Tech
- Stone Masons commonly used for Virginia Tech projects
- Field coordinator