THESIS PROPOSAL

National Intrepid Center of Excellence
Bethesda, MD

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Ronza Abousaid
AE Faculty Consultant: Dr. Christopher Magent
Construction Management

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EXECUTIVE SUMMARY

The following proposal is intended to provide an overview of the four topics that will be researched as a part of a thesis report on the National Intrepid Center of Excellence. The topics include: Project delivery method, using BIM as a better communication tool, 3D estimating, and the benefits of having an energy efficient heat recovery systems.

Analysis I

This project is being delivered under a CM-at-Risk contract between Turner Construction and the owner. Turner was brought on board well after the design had been in progress. This has had an effect on the project in some ways including: schedule delays due to the lengthy value engineering process resulting from a design which came well over the owner's set budget, having the owner carry the responsibility for the delays caused by the distorted usages of BIM on this project, and having some of building's systems, such as the air handling unit, be well over designed since the MEP trades were not involved in the design phase for any guidance. Having a design-build delivery method is expected to eliminate most of the issues mentioned above.

Analysis II

The National Intrepid Center of Excellence is utilizing BIM techniques for coordination between the design and construction of the project. Poor communication between the designers and the GC during the value engineering process has caused many delays and lost cost on this project. The BIM model was not used as a continuous working model by the project team. Having an in house BIM execution plan along with all the requirements and responsibilities set by the contractor is expected to utilize BIM as a better communication tool on this project as well as in the construction industry.

Analysis III

During the 5 month period of the value engineering process done on this project, estimations were required to be calculated in order to assure the building cost meets the required owner's budget. Turner Construction was estimating all the material, labor, and equipment using 2D drawings. This was a very lengthy and repetitive process which had taken much longer than needed. Utilizing BIM on a project and not taking the advantage of all what BIM has to offer decreases the benefits of exploiting such a new set of technology. In using 3D cost estimation software, it is expected for this process to be more efficient, save money, and time on the project during all estimation stages.

Analysis IV

The lack of specialty contractors on the project as early as the design phase can affect the efficiency of the design and construction of the building systems. Heat recovery systems can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost. These heat recovery systems include a flat plat heat recovery systems or enthalpy wheals. It is expected for these low life cycle cost systems to be beneficial for both the owner and the building's energy efficiency.

This analysis will also include a weight matrix, which is provided to illustrate the distribution of the time and effort among the proposed analyses as well as a summary of both breadth topics included within the research.

PROJECT BACKGROUND

The Intrepid Fallen Heroes Fund, a national leader in supporting the men and women of the United States Armed Forces and their families, has launched an important new effort to serve our military community. The Fund is building the National Intrepid Center of Excellence (NICoE), an advanced facility dedicated to research, diagnosis and treatment of military personnel and veterans suffering from traumatic brain injury (TBI) and psychological health issues.

NICoE will be a 72,000 square foot, two-story facility located on the Navy campus at Bethesda, Maryland, adjacent to the new Walter Reed National Military Medical Center, with close access to the Uniformed Services University, the National Institutes of Health, and the Veterans Health Administration. NICoE will be designed to provide the most advanced services for advanced diagnostics, initial treatment plan and family education, introduction to therapeutic modalities, referral and reintegration support for military personnel and veterans with TBI, post traumatic stress disorder, and/or complex psychological health issues. Further, NICoE will conduct research, test new protocols and provide comprehensive training and education to patients, providers and families while maintaining ongoing telehealth follow-up care across the country and throughout the world.

The building broke ground on March 6th, 2009 and is scheduled to be completed within a 16 month period. Turner Construction is the construction management group on site along with Smithgroup, which is the design firm for the NICoE project. This project is expected to acquire LEED certification, which will meet the standards of the USBGC. Additionally, Building information modeling (BIM) is used in the design, value engineering, and construction phases of the NICoE project. This project will be delivery as a CM-at-Risk contract between Turner Construction and Smithgroup. The mechanical and plumbing package will be done by Turner in a design – build method. The initial budget is approximately $65 million under a GMP contract.

The design features are highlighted on the northwest side of the building. It is composed of an exterior curved curtain wall system along with concrete precast panels extending the height of the building 38’-8”. This houses the healing and public areas of the building such as: auditorium, waiting rooms, lounge, the media “Dive” room, the CAREN (Computer Assisted Rehabilitation Environment) and the spacious lobbies. Situated within the building on the East and south side are clinical spaces which include: MRI rooms, PET/CT rooms, physical, occupational, recreational therapy, Sleep labs, Research Tech, and other support spaces. There are two different roof levels that towers the building. The low roof extends throughout the east and south side and holds some of the heavy mechanical equipment. The high flat roof ties into the curved curtain wall system on the north east and west side of the building giving it a special architectural feature. Finally, spacious lobbies and playground areas are provided for the friends and families to relax while their loved ones are being treated.

ANALYSIS I: PROJECT DELIVERY METHOD

Problem:

As mentioned above, the project is being delivered under a CM-at-Risk contract between Turner Construction and the owner. By the time Turner was brought on board the design of this project was more than 60% complete. A rough order estimate was done by Turner in order to identify if the current design cost will meet the owner's budget. The estimate came well above the owner's expectations. Turner's contract required them to assist the design firm in completing the design within the required budget. Since Turner did not have a contract with SmithGroup, issues arose when it came time to eliminate some of the design features of the building. Turner began with an estimated cost of $63Million dollars. A second estimation was calculated during the 80% completion stage of the design phase. Turner was successful in lowering the estimate by 8%. This estimate was again well above what it is intended to be. By the time the design was complete it was still almost 20%above the set budget.

The design was complete and it was time for the owner to review it and approve the cost. The cost of the design was still above what the owner required. Therefore, value engineering had to be done on the original design. Massive amounts of design changes took place in the 5 months of the value engineering period.

Going through the VE process with the contractor, owner, and designer had its own challenges as well. The distorted usage of the BIM model during the VE process caused the project a 2 month delay (Analysis II). The estimation process used had caused the VE period to last much longer than expected (Analysis III). Lastly, some of the building's systems, such as the air handling unit, was missed and not discussed during the VE period (Analysis IV).

Potential Solutions:

It would have been beneficial for this project to have been delivered as a Design-Build project. Moving towards an integrated design and construction process.

Methodology:

1. Interviewing a project similar to the National Intrepid Center of Excellence which is using a Design-Building delivery method and analyze the industry point of view for the different project delivery systems.

2. Identify the advantages and disadvantages of a CM @ Risk and Design-Build delivery method.

3. Analysis the appropriate project delivery method for NICoE using the project delivery method selection systems.

4. Identifying the potential to leverage the BIM model in the process of a Design-Build project.

5. Conduct a schedule analysis for both delivery methods.

6. Identify the design-build delivery method step-by-step process.

Preliminary Resources and Tools:

- Civista Medical Center, La Plata, MD. – Gilbane Building Company, Design-Building project utilizing BIM.
- Design Build Solution Inc.
- CII-construction institute industry research team – Project delivery method selection system.

Expected Outcome:

Most of the issues mentioned above can be solved if the owner had one contract with Turner Construction. Turner could have been involved with the design from the beginning and been more conscious of the set budget. A design-building method would have also eliminated the 5 months worth of VE done to decrease the building cost. In addition, Turner would have involved their MEP trades earlier on for recommendations on the building's systems used.

ANALYSIS II: USING BIM AS A COMMUNICATION TOOL

Problem:

The National Intrepid Center of Excellence is utilizing BIM techniques for coordination between the design and construction of the project. A 3D Revit model was developed by SmithGroup in the design phase of the project. The model included the structural, mechanical, plumbing, electrical, exterior and interior architectural features. Turner was given access to the NICoE model upon joining the project. Turner Construction then studied value engineering ideas that had potential to be used on the project to meet the required budget.

The Value Engineering process went on for approximately 5 months, beginning in August 2008 and ending in December 2008. Once VE ideas were approved by the owner, they were documented to apply those changes onto the model. Since the VE period lasted for over 5 months, VE meetings were held once a week with massive amounts of changes suggested by Turner and SmithGroup, some of the changes were not applied immediately. Therefore, the BIM model was not used as a continuous progression working model. Moreover, the 3 other design engineers were never required to update their model and resubmit. The model update requirements and responsibilities were never explicitly assigned.

Poor communication between the designers and the GC during the value engineering process has caused many delays on this project. A drastic change that was not implemented on the 3D model during the VE stage is lowering the second floor ceiling height by 2'-8", which meant less plenum space available. Therefore, after the VE process ended and weekly coordination meetings began, the project team were using the original 3D model without the new and approved ceiling height of 15'. This meant that all clash detection between MEP and structural trades were being run according to the original ceiling height of 17'-6". Figure 1 is one of the resulting issues that have been affected by this problem. Once the work began on the first floor, the problem became apparent.

Figure 1 – 2nd floor ductwork and plumbing clashes

This issue caused Turner Construction a batch of lost coordination time and wasted cost to the project. Resulting from the two month delay which was required to update all value engineering changes to the 3D model and rerun all clash detections and coordination between trades.

Potential Solutions:

Have a clear BIM execution plan which can be used by the project team throughout all stages of the project. Clearly identify the modeling requirements and responsibilities for the project team in all contracts. Develop a 3D model which is a continuous progression working model used throughout the lifetime of the project. Use BIM as better communication tool between all parties involved.

Methodology:

1) Gaining access to the 3D model used on this project.

2) Modeling the original ceiling height that was used during the coordination meetings.

3) Presenting 3 different spaces which were affected by not having a continuous working model during the progression of the project.

4) Looking into the contract language concerning the BIM application requirements for all subcontractors, designers/engineers, architect, and contractor on this project.

5) Developing the coordination and communication BIM execution plan which can be used by the project team throughout all stages of the project.

6) Analyzing the schedule effects that have resulted from this distorted process and lack of communication between the project team.

7) Getting a rough cost estimate from the PM for the effects that this issue had on the project.

8) Identifying the benefits and challenges in using BIM in the current industry.

Preliminary Resources and Tools:

- Daniel Fernados – Turner Construction's BIM coordinator on the NICoE project.
- David Wysong, SmithGroup, Owner representative – All parties involved during the VE stage of this project.
- Craig Dubler – Involved in BIM execution planning in the Architectural Engineering department of Penn state.
- Revit Architecture, Navisworks, Projects

Expected Outcome:

Implementing BIM on a building project without having a BIM execution plan in house will have a drastic effect regarding the process, requirements, and responsibilities of the BIM applications. It is important for all BIM requirements and responsibilities to be included within all contracts and the contractor goes over those responsibilities to assure that all parties are on the same page. After interviewing all parties involved within the VE process and analyzing the effects caused by this issue, it will be apparent that executing a progression working 3D model to be used as a communication tool throughout the life time of the project is very beneficial to the project team.

ANALYSIS III: 3D ESTIMATING SOFTWARE

Problem:

Continuing on with improving the lengthy VE period on this project, the estimating of the VE ideas had taken much longer than expected. There had been significant amount of changes that were implemented on this project. Changes took place beginning from cutting the building's square footage to changing the interior finishes of some of the laboratories. Turner Construction spent massive amounts of time and a number of resources on estimating the ideas suggested during the VE period. Materials being added or removed from the original design were taken off by hand using the 2D construction documents. It was very important to the owner to understand the cost impacts that will be affected by the Value Engineering ideas before he approved any of the suggestions made by Turner and SmithGroup. Therefore, this process became very redundant and time consuming to the project team. Various amounts of money had been spent on this process that took much longer than it was intended for.

Potential Solutions:

Using the developed 3D model, there are several software products available which contain more efficient and faster estimation feedbacks. These different software packages should be analyzed for potential benefits to be used during the VE estimation period. The analysis will compare new products such as Revit Quantity schedules to the traditional estimating methods used.

Methodology:

1) A material quantity comparison between the original curtain wall system design and the new and approved system will be estimated using the traditional hand takeoffs from the 2D construction documents.

1) Estimating the pricing for material, labor, and equipment used for both systems using RS Means 2009.

2) Revit Quantity Schedules will then be used to estimate the quantity of the material used in both structural designs.

3) The quantities originated from Revit Quantity schedules will then be matched to RS Means cost data.

4) The final cost of the proposed change will be calculated using both hand and Revit Schedules takeoff quantities.

5) The number of hours spent using traditional hand methods and the number of hours using Revit Schedules will then be recorded for comparison.

6) Interviewing a construction firm which uses BIM as an estimating tool and identify the time savings they benefit using this system.

7) Also from the interview, identify the challenges of working with designers when using the model during the process of estimating.

Preliminary Resources and Tools:

- RS Means 2009
- Revit Quantity Schedules
- Civista Medical Center, La Plata, MD. – Gilbane Building Company, BIM estimating

Expected Outcome:

Using 3D cost estimation software will be much more efficient and faster than the traditional hand takeoffs used during the VE period of this project. If the 3D cost estimation software was used, the money saved would have been used elsewhere or simply had more money in contingency for any unexpected constructability issues on the project.

ANALYSIS IV: HEAT RECOVERY SYSTEMS

Problem:

The original design of a field erected air handling unit located on the second floor in the mechanical room is used as a main source for cooling the building. The AHU's supply airflow maximum is 86,000CFM and minimum of 68,000 CFM and delivers a 100% fresh air supply throughout the building. As mentioned earlier, this field erected air handling unit was claimed to be an over-designed system. It is one of the effects of not having the MEP trades involved earlier on with the project. This system had been designed based on all hospital requirements. A detail that was overlooked when designing the system is that the NICoE facility does not emit any natural gases in the labs, which would have required a 100% fresh air supply.

The over design of this system along with the field erection decision, has resulted in a much higher cost and more time required on the project schedule for the erection of the unit. Therefore, during the beginning phases of the construction services, Turner suggested to redesign an alternative air handling unit system which would be a better fit for this facility. Limback Company (MEP) came up with an alternative AHU that is currently used in this facility.

This system is a much better fit than the original design but lacks the energy efficiency due to no heat recovery within the system. Electricity and gas cost could be saved for the owner when using a heat recovery within the AHU systems.

Potential Solutions:

There are many heat recovery systems that can be as high as 90% efficient used along with the AHU system. These heat recovery systems included a flat plat heat recovery system or an enthalpy wheal.

Methodology:

This analysis will research the heat recovery system that is appropriate for the AHUs used for this facility. Also, interviewing a Mechanical contractor on the amount of involvement they have during the design phases and the cost saving effects when their input is used earlier on the project.

Preliminary Resources and Tools:

- ASHRAE standard 62.1 & 90.1
- Hoval – Heat recovery heat systems
- Xetex Selection Program Version 1.1.14

Expected Outcome:

A heat recovery ventilator (HRV) can help make mechanical ventilation be more cost effective by reclaiming energy from exhaust airflows. HRVs recapture 50 to 90 percent of the conditioned temperatures that would otherwise be lost. Many cost savings and energy recovery can be reclaimed to both the owner and the environment's benefits.

CONCLUSION

Although there are several problematic features on the National Intrepid Center of Excellence, the four analyses listed above were chosen due to my interest in the topics, recognizing that I will be performing research on issues that I will enjoy. Also, the educational value of research and analysis that I will be completing will be beneficial to my future career in the construction industry. All four analysis are tied together to make up for a solid research topic, which involves the opportunity of using and expanding my construction management knowledge and skills.

WEIGHT MATRIX

The weight matrix below represents how time will be allocating among the research and analyses previously mentioned within this proposal.

Description	*Research*	*Value Engineering*	*Constructability Reduction*	*Schedule Reduction*	*Total*
Project Delivery Method	20%	-	-	10%	30
BIM As a Continuous Working Model	-	10%	15%	5%	30
Estimating Using BIM	10%	-	-	5%	15
Heat Recovery Systems	-	10%	10%	5%	25
Total	30%	20%	25%	25%	100

APPENDIX A | BREATH EXCERPTS

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Mechanical – Heat Recovery Systems

In conjunction with the heat recovery system designed to fit the AHU used in this project (Analysis IV), I will be performing mechanical calculations to help assess the design of the heat recovery system. Specifically, calculating the actual CFMs required for this facility and comparing it with the alternative design. Next, i will contact a heat recovery system manufacturer and used the appropriate software to design a heat recovery system according to the outside air supply required for NICoE. I will compare both systems regarding the energy recovery and cost savings made when using these heat recovery systems.

Structural – Precast Wall Panels to Insulated Metal Panels

The model-based cost estimating process (3D estimation) can also be used during the Value engineering process to evaluate the cost of design and construction alternatives as mentioned above. An alternative wall panel system will be investigated to compare the current 7" thick precast concrete panels used in conjunction with the curtain wall system on the northwest side of the building. Within this analysis I will be looking into the lateral and deal load changes on the structure and foundation of the building to the lighter loads applied.