Kaiser Permanente Largo Medical Office Building – Largo, MD

Christopher Pozza - CM

Driving Schedule
Thesis Proposal

December 14, 2012

Advisor – Rob Leicht

Executive Summary

The following report includes the proposed analyses to be conducted during the spring semester. Ideas for these analyses have been developed during the fall semester throughout extensive research performed for each of the three Technical Assignments. Schedule has been the biggest challenge since before construction could start, so all four analyses are schedule related or are expected to include schedule savings. Related structural and mechanical breadth studies are discussed in **Appendix A** while a schedule to complete all work can be found in **Appendix B**.

Analysis #1: Effect of the Change Order Management Process

Change order management has been noted by the project team as one of the biggest challenges. It is believed that researching the change order management process will reveal how the project team and laborer morale have been negatively impacted throughout construction due to a large amount of waste and value loss in this process. All steps will be investigated and specific problematic examples chosen to perform a value stream analysis; identifying where value is added or it is a wasteful step. Required extension of the schedule is also assumed to be, in part, due to the change order management process and how untimely decisions have hindered construction and caused otherwise avoidable delays.

Analysis #2: Implementation of Precast Panels

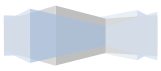
This analysis includes both breadth studies. Hand-laid brick was used on this project, which the mason suffered major setbacks due to weather delays and drawing detail issues. It is expected that the use of precast panels could eliminate significant time and greatly reduce site congestion. Changing the materials used on the façade and how those materials are supported will potentially have major impacts on other building systems. A breadth study including the structural analysis will be conducted to determine if steel will have to be upgraded. A separate breadth study will include the impacts on the mechanical system due to a change in the façade materials and insulation properties.

Analysis #3: Use of Virtual Mock-Ups for Connection Details

BIM was used on the project, although not to its full potential. Details of the addition's connection to the existing building were deemed unachievable the way they were shown on the drawings. Because a viable solution was neither found easily nor found early in construction, this is an example where virtual mock-ups could have been utilized and added value to the project. A virtual mock-up will be created as well as an analysis determining whether the cost benefit and applicability of using mock-ups on this project would be deemed feasible.

Analysis #4: Modularization of Headwall Units

Modularization was a major discussion topic at the PACE Roundtable as prefabrication is becoming more prevalent in the construction industry. Headwall units involve work to be done by several trades, and there are 49 total units in this building. It is believed productivity will significantly increase as complex connections in tough-to-reach areas, now pre-assembled, will allow trades work to flow much smoother throughout the building, preventing bottlenecks at headwall units in each room. Costs and schedule impacts of using modularized headwall units will be analyzed.



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Analysis #1: Effect of the Change Order Management Process

Problem Identification

Both Technical Assignments 2 and 3 discuss the project's challenging schedule throughout construction of the Kaiser Permanente Largo Medical Office Building. Management of change orders has proved to be a major challenge, especially as time plays such a critical role in this process. Research impacts due to the change order management process used by Kaiser Permanente will be investigated in order to document the effects the project has experienced as a result.

Background Research

Technical Assignment 3 includes the initial research investigating management's process of change orders. The effects have been seen first-hand throughout a summer internship on this project and after interviewing team members, it has been agreed that there is potential for improvement. The process currently implemented has cost the project critical time, negatively impacting the project. It has also been discovered, since the time the internship has ended, that a crew has been established on site dedicated completely to working on change orders. Studying this process will be considered the critical industry issue that will be researched.

It will be very important to understand the entire process from the time an RFI is created, until it is passed to and from the construction manager to Kaiser Permanente for approval. This will be very helpful for knowing the impacts the process has on the schedule. Administrative costs have the potential to be determined if specific change orders are selected to study in more detail. Labor costs associated with change orders can also be tracked. This project presents a unique situation as there is a crew dedicated specifically to change order work. This crew wears a blue vest, differentiating members from laborers performing work as originally scheduled.

Potential Solutions

1. Raised Owner awareness of impact of change order process impacts
2. Owner and project team understanding of why process is inefficient
3. Alternate ways to approach change orders to possibly be implemented for future projects
4. Discover ways to eliminate waste in change management process

Analysis Procedure

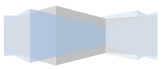
- Interview John Stull of DPR and both Cy Zinn and Alton Milwood of Jacobs
- Identify four specific change orders that have proved troublesome on the project
- Determine which change orders had work that affected the critical path
- Interview Michael Hudak and Tony Gil of DPR
- Determine labor and administrative costs associated with the selected four change orders
- Estimate total schedule impacts or delays due to change order

Resources & Data Collection Tools

- Project Team Members
- Documentation of labor hours tied to change order crew work
- Penn State AE Construction Faculty
- Kaiser Permanente Representatives
- "Lean Thinking" – potential ideas to eliminate wasteful processes
- Online articles or journals related to change order management processes and their effects

Expected Outcome

It is believed that researching the change order management process will reveal how the project team and laborer morale have been negatively impacted throughout construction. It is assumed that a large increase in project cost will be due directly to change order work and managing these changes. Required extension of the schedule is also assumed to be, in part, due to the change order management process and how untimely decisions have hindered construction and caused otherwise avoidable delays. Finding potential opportunities to improve this process or at least make owners aware of the current effects of the process in place can hopefully improve future construction projects.



Analysis #2: Implementation of Precast Panels

Problem Identification

As mentioned previously, schedule has been a key factor since before construction started. Air/Vapor barrier connection details provided for around windows were not clear initially. Details were tied to requests for information (RFI's) that took significant time to be answered, holding up construction of the exterior brick façade. Weather delays in early months of construction also caused the Watertight Milestone to be delayed.

As discussed in Technical Assignment 2, site congestion was caused due to the large amount of laydown area taken by brick and insulation material. The building footprint takes up a large amount of space on site. Fraco Lifts were used around the south and east facades, taking up more valuable space and limiting the access into the building for an extended period of time. The use of panels has the potential to significantly reduce critical schedule time. Although it would potentially add cost, extensive investigation to determine an alternate system is required.

See **Appendix A** for the two related breadth studies that will be related to this depth. A structural steel breadth analyzing the additional loads to be carried by the building's structure, and a mechanical breadth that analyzes the insulation properties of the panels compared to the components making up the original design.

Background Research

Use of prefabrication and modularization was a major discussion topic at the PACE Roundtable. Producing and combining more components off site allows for much quicker field installation, which would be very beneficial for this project. As the hand-placed brick quickly fell behind schedule, it was nearly impossible to make up for the time that was lost due to weather and other delays. Putting more manpower for longer-than-normal hours to try to make up for time had significant costs associated with it, much more extensive than labor cost to fabricate panels in a shop.

Superintendents specifically recommended researching the use of precast panels versus the hand-laid brick due to the delays and difficulties faced throughout construction. For the addition, AECOM architects decided hand-laid brick would best match the quality of the connected existing building but Endicott Brick, fabricator of brick precast panels, could possibly match the level of quality desired. After discussion with an Endicott Brick representative, it has been noted that several projects he has dealt with have specifically involved additions, comprised of precast panels, to existing buildings that have hand-placed brick façades.

Potential Solutions

1. Use of prefabricated panels will be deemed practical due to shortened schedule time and overall cost savings associated with labor expenses, structural modifications, and mechanical system changes.
2. Investigations prove that use of prefabricated panels will not be deemed practical relating to schedule, labor expenses, structural modifications, and mechanical system changes.

Analysis Procedure

- Determine three precast panel manufacturers in the Washington DC Metro Area
- Develop a pro/con list of each to make appropriate manufacturer selection
- Conduct four interviews: two Calvert Masonry foremen, a DPR superintendent and project manager
- Determine total time and cost to install brick façade
- Create precast panel design, finding sizes and amount of panels necessary
- Estimate time and cost to fabricate, deliver, and erect precast panels
- Perform a cost and schedule comparison
- Calculate general conditions cost savings or additions

Resources & Data Collection Tools

- DPR Project Team
- AE Construction Faculty
- AECOM Architects and In-House Engineers
    - Structural Engineer
    - Façade Designer
    - Mechanical Engineer
- Industry Professionals
- Endicott Brick and Nitterhouse Concrete Representatives
- Appropriate design software
- Material specifications from precast manufacturers
- Crane specification to determine sizing and logistics for site

Expected Outcome

It is expected that schedule time will be reduced due to lack of weather impacts and quicker installation. Site congestion will be reduced and watertight milestone could have been reached as originally scheduled. Costs will most likely be more expensive due to transportation costs, cost of equipment required for erection, and other costs to be discovered with a more in-depth investigation.

Analysis #3: Use of Virtual Mock-Ups for Connection Details

Problem Identification

Using virtual mock-ups are often beneficial to all parties involved as cost of labor and materials are greatly reduced, if not entirely eliminated, compared to fabricating physical mock-ups. It is also beneficial to show project team members, including designers, engineers, and laborers; that details on drawings physically work and can be constructed with the level of quality necessary. Virtual mock-ups have a much higher potential to be worthwhile on a project when the BIM is used, as it was on this project, but were not taken advantage of on this project as DPR originally intended.

Because the project involves an addition connecting to an existing building, details were produced describing how flashing and other materials would tie into the new and old structures. The original details provided proved to be extremely challenging, as no member of either the general contractor or subcontractor responsible for installing the work had seen a detail like that before. After investigating it further, it was deemed that the detail used could not be built. Had the detail been created in a virtual mock-up, this would have been discovered much earlier and most likely led to a quicker solution. With several connections and passages between the addition and existing building, time and effort could have been saved before construction of these areas was approaching.

Background Research

As discovered in Technical Assignment 2, virtual mock-ups were originally going to be created for an operating room, patient room, an office, complicated details, and others. Because coordination of the BIM model took nearly twice as long as expected, time was never allotted for mock-ups to be created virtually so no one was able to reap the benefit of having them.

Technical Assignment 3 discusses the project that was discovered, regarding details of connections between the addition and existing building. New details were needed which had a negative impact as this was a laborious process. Creating the details would have showed the difficulty involved with the original design, and a solution could have been discovered much earlier.

Potential Solutions

1. Virtual mock-ups would be deemed a viable solution to implement early on the project and costs to produce them would outweigh associated costs of producing an alternative solution, also saving time in the process.
2. Virtual mock-ups will be found to save time, but would not provide any cost benefits.
3. Virtual mock-ups will not save schedule time or money on the project and therefore be unfavorable for use on this project.

Analysis Procedure

- Interview the project BIM Champion, Matt Hedrick, to understand process of creating virtual mock-ups
- Conduct two additional interviews, with a project architect and site superintendent, for more information regarding pros/cons of implementing virtual mock-ups
- Define the four best applications for use of virtual mock-ups specifically applicable to this project
- Investigate costs due to RFI's and change orders for at least two specific locations where virtual mock-ups have been deemed viable
- Research costs and time associated with generating virtual mock-ups
- Estimate any expected schedule impacts and associated lead times
- Compare what was actually built to the original design and investigate scope changes

Resources & Data Collection Tools

- DPR Project Team
  - BIM Champion
  - Superintendents
- AE Construction Faculty
  - Dr. Messner
- AECOM Architects and In-House Engineers
  - Structural Engineer
  - Façade Designer
  - Mechanical Engineer
- Industry Professionals
- Appropriate design software
- Appropriate documents, articles, or journals

Expected Outcome

It is expected that costs to create virtual mock-ups will take significant time, but the costs of doing so will save the project money when taking into consideration the cost finding a solution for the original detail. Mock-ups will be found to make the construction process go smoother as subcontractors are able to see drawings in three dimensions, navigate about them and visualize how work is to go in place. Similarly, use of virtual mock-ups most likely would have reduced some of the issues with flashing details around windows, which significant delayed the mason's progress as new details were being produced by the architect.

Analysis #4: Modularization of Headwall Units

Problem Identification

As discussed previously, the project schedule is very challenging. Having too little time to do too much work was common on the project. Headwall units involve work to be done by several trades as they are tied to power, medical gas, nurse stations, and other systems. There are 49 total units in this building. Because headwalls are complex, preventing bottlenecks or the need to perform extra sequencing for trades to work around each other could have been eliminated by modularizing headwalls.

Background Research

Modularization was a major discussion topic at the PACE Roundtable as prefabrication is becoming more prevalent in the construction industry. More systems are able to be modularized as technology improves and schedules sometimes don't permit work to be finished on time without the use of modules. Project team members recommended prefabricating headwall units because of the significant time that each trade spends on each unit. This medical office building has two different types of headwalls; 42 of Type 1 and 7 of Type 2. With so much repetition, work between different rooms could be much better streamlined as trades won't be required to spend nearly as much time dealing with the headwalls.

There is significant lead time associated with any sort of modules, but being that they are installed relatively early in the construction process (compared to other medical equipment that waits as long as possible to have cutting edge technology, such as MRI equipment). Headwalls tend not to be changed, so early design is more likely to be successful than other medical equipment. After discussion with industry professionals at the PACE roundtable, it was noted that headwalls are commonly prefabricated successfully and would be a good area to analyze for a thesis project.

Potential Solutions

1. Works and Saves time/money, works and saves time/not money, works and doesn't save time/money
2. Schedule savings due to quicker installation time and less time required to make connections by each subcontractor required to tie into headwall systems
3. Cost for producing modular units will be more expensive than traditional installation methods used on this project, but it can be compared to schedule to see if time savings are significant enough to have a large impact on the schedule

Analysis Procedure

- Create pro/con list of modularization
- Interview Andy Rhodes from Southland to understand applications and steps required for implementation of modularization
- Conduct three interviews with project team members and architect, Steve Willey, to determine at least two manufacturers capable of fabricating headwall units
- Select a manufacturer best fit for use on this project and interview a representative to determine lead times for producing units
- Determine time and cost to transport and install units
- Consult with project team to calculate cost and time laborers actually spent installing units
- Perform cost and schedule analysis with gathered information
- Calculate additional general conditions costs or savings

Resources & Data Collection Tools

- DPR Project Team
  - Project Engineer responsible for headwall scope
- AE Construction Faculty
- AECOM Architects and In-House Engineers
- Industry Professionals
  - Andy Rhoades of Southland
- Appropriate documents, articles, or journals

Expected Outcome

It is expected that modularization of headwall units will have a much larger cost initially, but significant labor time, congestion, and rework will be eliminated. Design will be required to be complete much earlier than what was actually done to prepare for lead times, but work will be able to flow much better.

Analysis Weight Matrix

Table 1 is a matrix has been created determining the breakdown for each of the four different analyses and their corresponding areas of investigation that will be addressed. It should be noted that percentages represent the amount of time and effort that is expected for each area of study.

Analysis Weight Distribution					
Analysis Description	**Value Engineering Analysis**	**Constructability Review**	**Schedule Acceleration / Reduction**	**Critical Issues Research**	**Total**
Change Order Management	-	5%	-	15%	**20%**
Virtual Mock-Up of Building Connections	10%	10%	5%	-	**25%**
Masonry Façade	5%	10%	20%	-	**35%**
Modularization of Headwalls	5%	-	10%	5%	**20%**
Total	**20%**	**25%**	**35%**	**20%**	100%

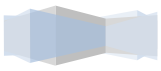
Table 1 - Analysis Weight Matrix representing the time and effort expected to be required for each analysis in their respective area of study.

Preliminary Schedule

A schedule has been created outlining the work that will required for each depth study, also including breadths. The schedule is broken into weeks with major milestones. Milestones will be closely monitored to ensure that enough time is provided for each study and that work is being completed in a timely manner. A legend is included to show each study's timeline. Four milestones are included, with a fifth milestone being submission of the final report on April 3, 2013. See **Appendix B** for detail.

Conclusions

The four depth studies and two breadth studies make up the entire thesis proposal for Kaiser Permanente Largo Medical Office Building. Each topic has suffered a significant loss of time due to the current change order management process, which will be the critical industry research topic for this project. All topics involve potential schedule savings, which is key because schedule has been the biggest challenge. It is expected that virtual mock-ups could be created relatively easily because the addition is already modeled, and these would add value to the project as different drawing details originally provided could not be made. Using precast panels instead of hand-laid brick is expected to save significant project time and provide an interesting analysis when taking into account the potential structural and mechanical adjustments necessary to be made. Finally, modularization of headwall units is believed to save significant project time. Although again this will have a higher upfront cost to prefabricate, it will be worth it due to the schedule challenges that developed on this project.



Appendix A

Breadth Studies

Structural Breadth

The Kaiser Permanente Largo Medical Office Building has a unique SidePlate Moment Connection System discussed in Technical Assignment 1. Because a precast system is being proposed, the structural system will now have to carry a larger load and most likely require upgrades. Steel upgrades would most likely require costly implications, and it will be determined whether or not the benefits during construction will outweigh the cost. Producers of panels will have to be consulted to determine expected loads of panels to know what the structure will have to support. Also, other design considerations will need to be investigated and consulting with the project's structural engineer will be necessary. Assistance will be sought from members of the project team that have worked with precast panels before, and both faculty members and students in the Architectural Engineering department.

Semester Tasks

- Interview Penn State AE faculty member Kevin Parfitt to develop a better understanding of all required steps and procedure to be taken for such an analysis
- Interview AECOM Structural Engineer for any and all assumptions made in calculating structural loads, any unique codes necessary to take into consideration, and learn more about SidePlate Connections
- Determine standard wind, snow, and other loads used for the Largo, MD area
- Identify how precast panels are going to connect and transfer load to structure
- Calculate additional weight and total load due to panels selected
- Resize structural steel members to safely support loads and comply with all codes
- Estimate cost for change of materials and determine whether crane used is still acceptable

Mechanical Breadth

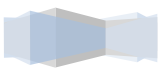
Precast panels have very different properties from a conventional brick façade. This will require investigation of the insulation properties of the panels that are chosen to be analyzed. Impacts on the mechanical system will vary with the change of seasons, and potentially have a significant impact on the energy costs to keep the building comfortable. Heating and cooling loads will need to be researched along with energy costs for the Largo, Maryland area. Some preliminary investigation of panels has revealed panels often have better insulation properties than traditional hand-placed brick. It will need to be investigated whether the mechanical system currently in use is the appropriate size and also lifecycle costs of the mechanical system will be analyzed to fully understand the effects of implementing precast panels on the project. It would be ideal if the panels would be discovered to actually reduce costs.

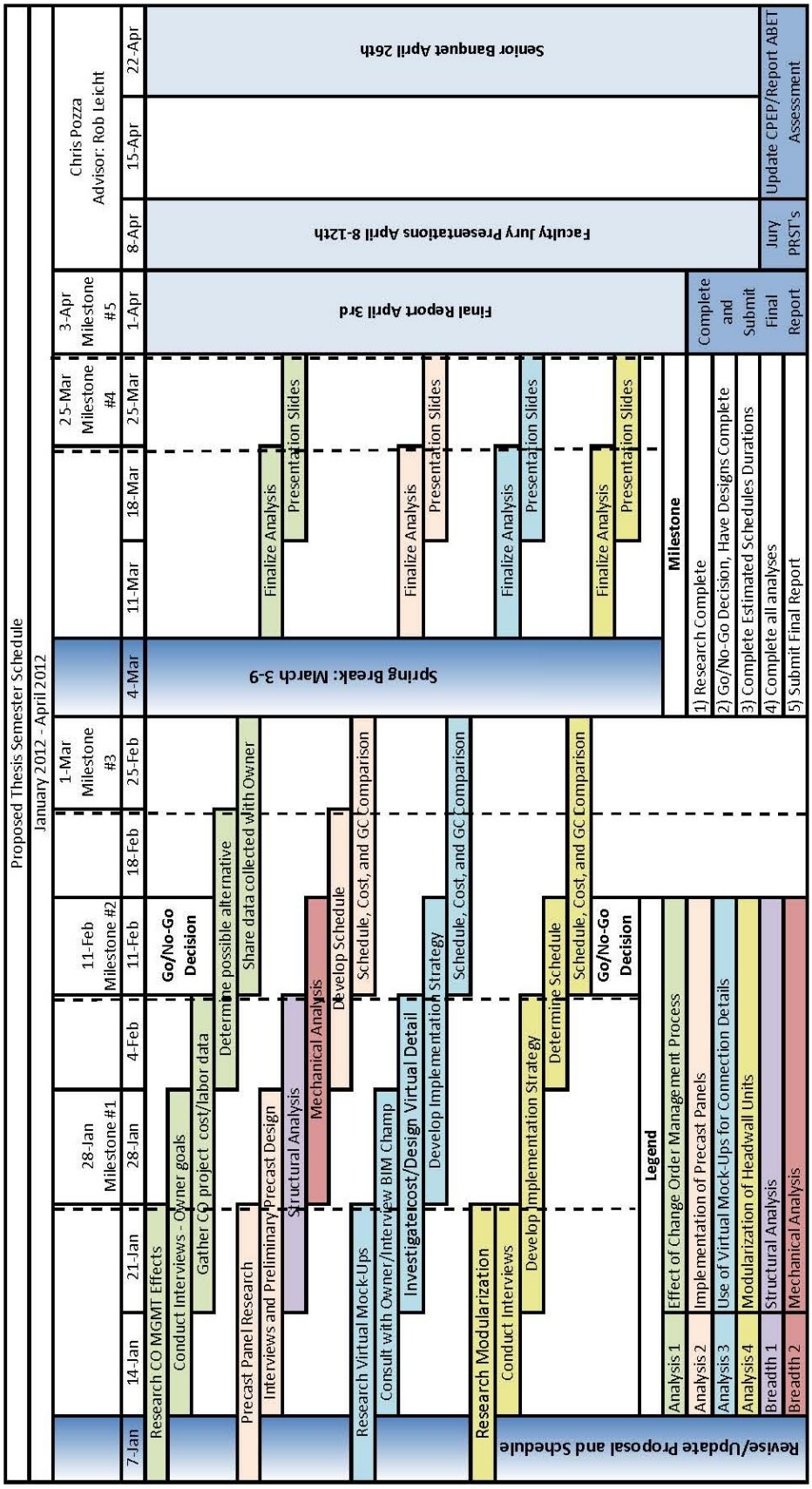
Semester Tasks

- Interview Penn State Mechanical Faculty member for appropriate steps to be taken to complete a successful breadth analysis and AECOM Mechanical Engineer for all assumptions and estimates used for calculations
- Determine insulation values of both actual brick façade used and proposed panels
- Compare loads and determine effects on mechanical system
- Recalculate and resize system components as necessary due to predicted load changes
- Estimate cost for any system changes
- Determine whether use of new system components and alternative façade system is still a logical alternative to be used on this project

Appendix B

Spring Semester Analysis Schedule




Proposed Thesis Semester Schedule
January 2012 - April 2012
Chris Pozza
Advisor: Rob Leicht
7-Jan
14-Jan
21-Jan
28-Jan
4-Feb
11-Feb
18-Feb
25-Feb
4-Mar
11-Mar
18-Mar
25-Mar
1-Apr
8-Apr
15-Apr
22-Apr
28-Jan Milestone #1
11-Feb Milestone #2
1-Mar Milestone #3
25-Mar Milestone #4
3-Apr Milestone #5
Spring Break: March 3-9
Final Report April 3rd
Faculty Jury Presentations April 8-12th
Senior Banquet April 26th
Update CPEP/Report ABET Assessment
Jury PRST's
Complete and Submit Final Report
Research CO MGMT Effects
Conduct Interviews - Owner goals
Gather CO project cost/labor data
Go/No-Go Decision
Determine possible alternative
Precast Panel Research
Interviews and Preliminary Precast Design
Structural Analysis
Mechanical Analysis
Share data collected with Owner
Develop Schedule
Schedule, Cost, and GC Comparison
Research Virtual Mock-Ups
Consult with Owner/Interview BIM Champ
Investigate cost/Design Virtual Detail
Develop Implementation Strategy
Schedule, Cost, and GC Comparison
Research Modularization
Conduct Interviews
Develop Implementation Strategy
Determine Schedule
Schedule, Cost, and GC Comparison
Go/No-Go Decision
Revise/Update Proposal and Schedule
Finalize Analysis
Presentation Slides
Finalize Analysis
Presentation Slides
Finalize Analysis
Presentation Slides
Finalize Analysis
Presentation Slides
Milestone
1) Research Complete
2) Go/No-Go Decision, Have Designs Complete
3) Complete Estimated Schedules Durations
4) Complete all analyses
5) Submit Final Report
Legend
Analysis 1
Effect of Change Order Management Process
Analysis 2
Implementation of Precast Panels
Analysis 3
Use of Virtual Mock-Ups for Connection Details
Analysis 4
Modularization of Headwall Units
Breadth 1
Structural Analysis
Breadth 2
Mechanical Analysis