Lowell Stine
CM
Dr. Leicht
Library in Metropolitan Washington, D.C
1/17/2014

Library in Metropolitan Washington D.C

Final Proposal

Picture Provided by Multivista from Onsite Webcam

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Executive Summary

Delays have occurred at early stages of construction on the library project. Caisson installation was the first area of the project that was crippled with lagging productivity due to refabricating work required for the rebar cages, which caused delays. Next, the steel erection progress took longer than expected because of the complexity of the structure and a less than ideal erection sequence. As part of procuring equipment, the Integrated Packaged Equipment Center (IPEC) has created delays in working out constructability issues related to coordination and the approval process. Throughout this proposal the main focus is to analysis what items could have been improved to accelerate the schedule or at minimum prevent the current delays from ever happening.

To start off the proposal, a research topic is introduced in which includes early involvement of specialty contractors. This analysis looks at the direct benefits both in preconstruction and during construction of getting design related feedback from the contractors who will be installing the work. Trades that will be analyzed in this topic include caisson installation, structural erection, the IPEC and/or MEP trades, and the curtain wall. Solutions will involve some combination of design-build contracts and design assist contracts. Items to be considered and researched during this analysis will be owner involvement, industry member interviews with Truland and other design-build firms, other scopes that would be benefited, when each trade will be brought on-board, what each trades involvement should or shouldn't be, and cases studies that used this type of building delivery system, such as the South halls Renovation.

An alternative structural steel erection sequence will be determined in the second topic. A 19 zone steel erection is currently being used on the project and is creating delays because of inconsistency of productivity. A variety of alternative erection sequences will be analyzed in the following criteria; affects on cost, schedule, site logistics, quality control, onsite safety, and other constructability related issues. Resources that can be used to design a new sequencing plan include structural faculty members, structural classes previously taken, and a 4-D structural model that will be created. A structural breath will be included in this topic, which will determine if the structural sequence is structural stable and if not, then redesigning it so it is.

It is believed that the IPEC may not be the proper selection of a mechanical room for this project because of the current delivery method. While the IPEC system is a great idea in concept, it may have constructability issues and project delivery system issues in this project, which caused delays in procurement and coordination. This topic will weigh the benefits of the IPEC over a traditional mechanical penthouse or mechanical rooms in the building. The creation of a decision matrix will determine the best system to use on this project. A mechanical breath will result from this analysis because if the mechanical equipment gets moved from the roof, then fans and pumps will need to be resized to ensure the system will function correctly.

During the caisson installation a delay emerged because onsite refabricating of the rebar cages were required. The fourth topic looks at ways rebar cages can be fabricated effectively without running into these problems. Three types of slices will be reviewed for strength, durability, cost, constructability, and productivity. Fully prefabricated cages, site built cages and prefabricated 5 feet cage sections will also be studied. How the cages are maneuvered can save crane time on the project. Contacts including Ray Sowers and Walter Schneider will be collaborated with to gain farther insight on this topic. Two case studies will also be used to compare fabrications methods with methods used on the library project.

Research Analysis Topic 1- Early Involvement in Design

Problem Statement

A critical industry issue that is affecting a wide variety of construction projects around the county is the lack of early design involvement of contractors and specialty contractors. Without certain critical construction information, design professionals simply do not have the construction knowledge that allows their designs to be the most effective for the constructability, the budget, and the schedule of the project. The Library in Metropolitan Washington, D.C. is being delivered using a typical design-bid-build project delivery system. Multiple different s scopes have encountered constructability or procurement issues during the construction phase of this project. Specifically, there is a need on the library project for early involvement of construction professionals during the design phase to benefit the overall constructability and feasibility of a variety of different systems.

Background Research Performed

Because the project is well into the construction phase, the results of this analysis will be hypothetical and will look at what could have been done to get early construction feedback. Scopes that have, as of now, experienced constructability concerns for the most part include; caisson installation, structural erection, the IPEC and/or MEP trades, and the curtain wall. Delays are being felt in the schedule due to rebar cage re-fabrication requirements for the caissons because the accrual bearing capacity depth was reached at a different depth than what was originally planned. A 50 feet cantilever portion of the building results in a somewhat complex structure with an abnormal erection sequence. Without proper understanding of how this structure works, this process is delayed and is currently on the critical path. An IPEC unit is a good design consideration in concept, however without early construction coordination and supplier input, the IPEC has created frustration and confusion. Shop drawing approval for the curtain wall system is taking longer than expected because the architect having issues determining if the supplied documentation is an equal representation of the specified curtain wall system. Overall, the design of these systems is well thought through and may be great in idea, but how they correlate to construction has gaps that could be benefited through early contractor involvement.

How early construction professional involvement should be handled on this project is particularly challenging. From conversations with the county owner, it would not be in the best interest of the owner to handle this process because the owner does not have the resources or the time to do so. Keeping this in mind, the construction manager would have to be the coordinator of any early collaboration process. Ideally this research topic will provide key information to the construction manager including when to bring each project team member on board and what exactly their role in design will be.

Potential Solutions

Possible solutions of this research analysis to include early involvement of key construction professionals could include the following.

- Analysis what the owner's constraints are as far as implementing early construction personal involvement.
- Determine which specific scopes will benefit the most from early involvement by creating a set or list of guidelines or examples that can be used to weigh which trades should get involved. Guidelines will be established from knowledge gained from case studies, interviews, and indicators that stand out among scopes.

- Establish what each scope will be required to do in the early involvement and what they will be involved with by analyzing what each of the trades determined above are responsible for currently and how complicated their work is to be.
- Evaluate when each party would be procured to maximize their design involvement benefits.
- Procedural recommendations and criteria to perform the early involvement process will be an end result of this analysis.

Approach

As a research topic, this analysis will include mostly research sources and an examination of how to accomplish a successful implementation of design assist and design-build packages. Considerations and methods of analyzing early involvement are as follows.

- Interview leading industry members that participate in design assist and design-build contracts often, that may include Southland project managers, Truland project managers, and Nutec Group's project managers. Refer to *Appendix B* for a sample questionnaire that will be used.
- The Design-Build Institute of America may be a useful resource in determining which type of involvement to use.
- Case studies will be used that include successful or unsuccessful early involvement on the South Halls Renovation project and the Pegula Ice Arena project.

Expected Outcome

It would be expected that this research analysis would yield a recommendation to use a combination of design-build work and design assist contracts on the library project. For some scopes such as the IPEC and curtain wall, it would be expected that a design-build agreement would be of most value. On the other hand, the structure and foundation may only need design feedback and assist to add the most value. Specific deliverables that would in theory be turned over to the owner or project team would include; hatched out packages, recommendations for when to involve who, what each scope's involvement will be, value added summaries, and overall implementation procedures. Benefits of using early involvement contracts will result in lower number of change order and RFIs, less constructability challenges, savings of time, easier coordination process, and better overall relationships on the project.

Analysis Topic 2- Structural Steel Sequencing

Problem Statement

Perhaps the most complex system the library incorporates is the structural steel system that results from the 50 feet cantilever in the northern corner of the building. Currently the structural steel erection is behind schedule for multiple different reasons, which may include improper resource allocation, improper understanding of how complex the structural system is, and/or a hard to understand and hard to follow steel erection sequence. For this analysis topic the structure for the building will be studied and fully understood and the structural steel erection sequence will be re-sequenced to see if there is a more efficient way of erecting the structure. Multiple different sequences will be analyzed in how they affect cost, schedule, site logistics, quality control, onsite safety, and other constructability related issues. This topic will also include a structural breath because structural redesign work may be required along with structural feasibility calculations for any sort of temporary support apparatuses, if any are used. See the Structural Breath section of *Appendix A* for more details on this proposed breath study.

Background Research Performed

As mentioned before, the current structural steel erection sequence is somewhat complicated and involves erection activities jumping around from location to location. As originally proposed, the structural sequence is broken up into 19 different zones. The current structural steel erection sequence can be seen is Figure 1 on the next page. At any given time, multiple zones are being erected simultaneously with crews going back and forth between zones. Approximately five workers from the structural steel specialty contractor are onsite. For about 80 percent of the steel erection there was a 200 ton crawler crane dedicated for steel erection. For the other 20 percent of steel erection there other smaller mobile truck cranes on site.

As a part of the bidding process to select a contractor, how the structural sequence was planned to be staged and carried out was an important question. This being said, the contractor, with collaboration of the structural steel erector, were to submit a steel erection and concrete placement sequence plan to the architect and the structural engineer on the project for proper approval. Therefore, the contractor was free to erect the structure in any way they feel fit, as long as it met the project schedule and could be approved by the structural engineer. This would not limit this analysis to specific methods designated by the structural engineer. This new sequencing plan must be of high quality to be approved by the architect and the structural engineer. It is felt that a more efficient and well-rounded sequence can be designed, one that would minimize the current delays.

Potential Solutions

Possible solutions of this analysis to include sequencing of structural steel erection could include the following. These are all options that will be considered and compared using criteria discussed in the Approach section below.

- A system of temporary shoring that is erected with the structural steel by floor, then when the structure is complete, the shoring can be removed.
- A method that erects the cantilevering portion of the building on the ground, then once completed, is jacked into place and connected with the rest of the building.
- A sequence that is altered slightly from the one currently being used, but that includes the trusses being welded together on the ground and then being lifted into place as one lift.

- A determination that the current sequence is the most efficient and cost effective option and that the other proposed sequences will negatively affect the project.

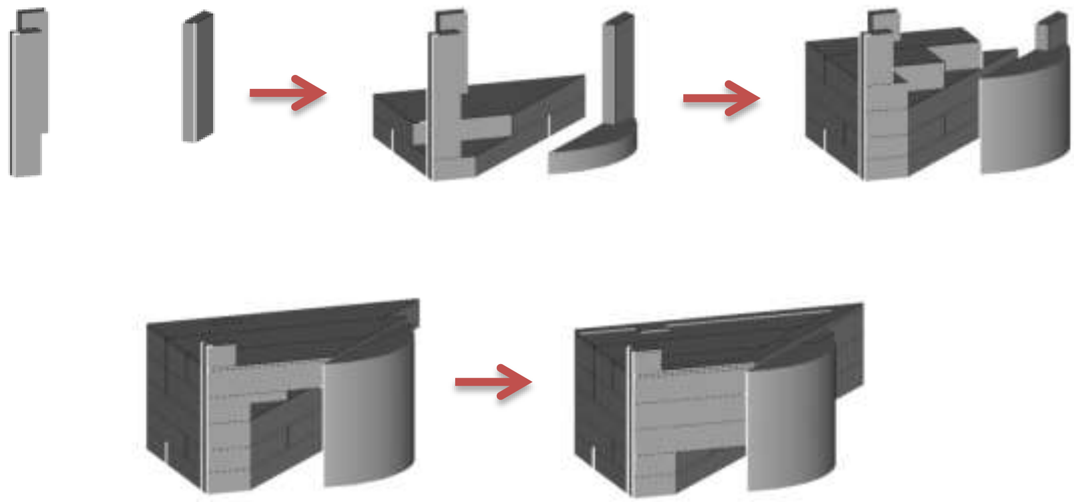


Figure 1: Current Structural Steel Erection Sequence

Approach

Considerations and methods of analyzing resequencing of steel erection may include the following.

- Possible sequencing and means and methods plan must be laid out to check the above proposed options and to brainstorm of others that may be more feasible. To develop options, structural faculty members, such as Dr. Boothby or Dr. Hanagan, will be consulted to discuss industry treads and new technologies.
- In the analysis of each option, a series of criteria will be established in which each option will be examined and compared. Criteria will be chosen with insight gained in past classes and through interviews with the structural faculty. The chosen criteria will then be compared and weighted in order to make a recommendation as to which option to use. Examples of such criteria may include cost (lower costs), schedule (shorter schedule), site logistics (level of site impact), quality control (lower possibility of quality issues), onsite safety (lower safety risks), and other constructability related issues, as mentioned before.
- The current and the two best sequencing options will also be modeled in 4-D using Navisworks to compare their flow or work.
- Based on the criteria mentioned before and the feasibility of the sequence, an option that added the most value to the construction process and most closely lines up with owner and contractor values would be selected to be recommended as the used structural sequence.
- As part of this analysis, a structural breath will have to be performed to ensure the overall stability and safety of each of the options, using knowledge acquired in AE 308, AE 401, and consulting with structural faculty.
- It would also be beneficial if this analysis was able to be tied back into Topic #1.

- Other resources could include steel erection specialty contractors, industry general contractors, American Institute of Steel Construction, standard steel production resources, and other steel case studies.

Expected Outcome

It is expected that the outcome from analyzing the structural sequence will result in a recommendation to redesign the steel erection sequence and potentially use an uncommon method of placing the steel that is required over the cantilever on the library project. It is also the hope that this new method will be beneficial to the schedule while keeping the cost relatively low. A balance of schedule, cost, and resources must be chosen to optimize the constructability of this unique structure, while keeping safety as a top priority. Overall, it is projected that this analysis will add value to the structural construction while benefiting the project as a whole.

Analysis Topic 3- Mechanical Penthouse vs. IPEC

Problem Statement

In the design of the library an Integrated Packaged Equipment Center (IPEC) was specified to house all the required mechanical equipment to make the building functional. During the design phase, the basis of design for sizing and designing the mechanical system for the building used a specific supplier's IPEC unit. Because of this, the specification was written in such a way that the contractor had very little flexibility when selecting an equal supplier and the contractor has not been able to get an approval to us any other supplier. This not only will raise the cost of the IPEC but also caused delays in procuring the unit because the contractor spent time trying to use a different supplier. As stated by the contractor, this alternative supplier would have added value to the project because they manufacture their own parts and could provide the system at a lower cost and within a shorter time frame. Problems have also arisen in coordinating with the supplier that was used for the basis of design. While the IPEC system is a great idea in concept, it may have constructability issues and project delivery system issues in this project, which caused delays in procurement and coordination. A comparison of the current IPEC system and a traditional mechanical penthouse will be performed in this analysis. A comparison of the two systems would provide insight as to if the IPEC system was the best selection for this project and this delivery type.

Background Research Performed

Currently the IPEC system that is going to be used for the building is a Resylution equipment center that houses a chiller, three naturel gas fired boilers, a heat recovery unit, two air handlers, multiple pumps, and a condensing unit. This unit is essentially a prefabricated mechanical penthouse that is lifted onto the roof when delivered to the site, and is 60' long, 40' wide, and 10' high. On the west side of the building there is a duct and pipe chase that runs from the IPEC to the third floor, which is used as a main supply and return air duct runs and pipe runs. As a mean of heat and cooling distribution the mechanical system in the building includes forced air ducts, a network of hydronic piping that feeds VAV boxes, hydronic perimeter heat, hydronic in-slab radiant floor heat, and a small amount of electrical radiant base board heat.

The supplier of the IPEC uses other manufacturer's equipment and parts inside their units. However, the supplier that the contractor could not get approved manufactured all of their own parts and equipment. This seemed to be beneficial, according to the contractor, in that quality control would be greater and the contractor seemed to think that the overall life span of the unit would be increased and making future repairs to unit easier.

To compare this IPEC system with a traditional mechanical penthouse, constructability concerns must be considered. A more permanent structure will have to be design and installed to act as an additional floor to the building, and not just a prefabricated box sitting on the roof. It is important to note at this time that the equipment currently designed to be placed in the IPEC will not have to be reselected in the mechanical penthouse option, but may have to be rearranged slightly. It is however important to consider the acoustical and vibration effects of switching from an IPEC to a mechanical penthouse, which is why an acoustical analysis will be performed as a breadth topic (see the Acoustical Breadth section of *Appendix A* for more detail about this breadth). Overall, this analysis would compare pros and cons of both systems while also comparing cost and schedule impacts, and this analysis could potentially help save a lot of wasted time, adverse relationships from forming, critical schedule and procurement time, and money in the budget.

Potential Solutions

Possible solutions of this analysis to include comparing the IPEC with a traditional mechanical penthouse could include the following options. These options below will be compared and contrasted using methods in the Approach section.

- A traditional penthouse or mechanical rooms inside the building could have been implemented in conjunction with the current project delivery system with recommendations as to what could have been changed if an IPEC system wanted to be used.
- A discovery that there is an alternative system that may be better than both an IPEC and mechanical penthouse.
- That the IPEC is the most feasible system to be implemented for this project and that early involvement of a mechanical specialty contractor could have prevented the issues that came up.

Approach

Considerations and methods of analyzing the differences between an IPEC system and a mechanical penthouse may include the following.

- Multiple different IPEC suppliers, other mechanical equipment suppliers, and mechanical option faculty (Dr. Ling) must be contacted to get a better understanding of each system and potentially discuss other options.
- Design firms, contractors with experience with each possible system, and design-build contractors will also be consulted to gain valuable knowledge of the pros and cons of each system. Such a firm may be James Posey Associates from Baltimore, MD.
- With this knowledge of how each of the systems works, a set of criteria will be established to evaluate the implementation of each on this project, which will lead to the creation of a decision making model to be used on other future projects. The decision making process will be laid out step by step to ensure the appropriate system is used for any project and project delivery system combination.
- Using the created decision tree, a recommended system will be established for the library project.
- The recommendation will be carried out even farther by performing an acoustical breadth for this analysis. This breath will include such things calculating decibel levels in the mechanical spaces and the library and calculating and estimating the transmission loss of the assemblies connecting the two spaces.

Expected Outcome

As of now, it is expected that the recommendation for the library project will yield a mechanical penthouse as the most buyable solution in this case. With the mechanical penthouse being the best solution for this project, it would add value to the project through less last minute coordination issues, minimal creation of delays, and more flexibility in laying out the required equipment. On the other hand, using a mechanical penthouse will require more in-depth upfront coordination to ensure very few problems will be encountered during construction. This is not saying that an IPEC is not a good system, but it may simply not be the appropriate system for this project. This analysis may or may not be able to be tied into Analysis Topic #1 in some way to offer more thought as to if an IPEC would be more appropriate in a design-build or design assist contract. This analysis will be greatly beneficial for future experience and has the potential of saving time on the schedule and saving the owner upfront costs.

Analysis Topic 4- Caisson Rebar Cage Fabrication

Problem Statement

Early in the library project, delays were caused by the caisson installation. Estimated caisson depths were given to the contractor while bidding the project for budgeting purposes. When the contractor was awarded the project, the estimated caisson depths were used to prefabricate rebar cages for the caissons. With the drilling rig on site, after drilling a few caisson holes, the contractor realized that the given depths were by no means an accurate estimate. Every caisson varied from the planned depth because structurally the caissons must be drilled to a depth that results in proper bearing capacity. As a result, every prefabricated rebar cage required some amount of refabricating on site to add or delete length. The schedule was impacted with a 15 day delay by this lower productivity of installing the caissons. Productivity of caisson rebar cages will be analyzed in this topic. Specifically, this topic will consist of alternative means & methods, best practices, and extent of prefabrication.

Background Research Performed

Throughout the building there are 42 caissons that vary in depths from 5 feet to 30 feet and in diameter from 36" to 72". Three groups of 72" caissons act as the deep foundation for the three mat slabs in the building. The structural stability of the building's foundation system is reliant on the caissons having the proper end bearing capacity. Each rebar cage is designed differently depending on each of the caisson's loading conditions and depth. When the rebar cages are placed, they are tilled up using a crane and lowered into place. Rebar sizes 9 through #11 are used to construct the rebar cages with #4 to #5 rebar ties. This analysis should benefit the planning, fabricating, installation, and means & methods of the rebar cages to improve production and constructability issues.

Potential Solutions

Possible solutions of this analysis of constructability issues with the caisson installation could include the following.

- Analysis which types of splices are appropriate; lap slices, welded splices or mechanical splices.
- A comparison of which fabrication techniques should be used for the rebar cages will be performed, which compares site built, fully prefabricated, and prefabricated sections. How the design of each cage will change depending on which method of fabrication is chosen must be considered as well.
- Choose installation methods to be used in placing the cages and how the sections will be joined together.
- Analysis whether a crane will be used in moving and lifting the cages or if they can be maneuvered by other smaller pieces of equipment.
- Include a cost and schedule analysis of splice types, fabrication techniques, and installation methods.

Approach

Considerations and methods of analyzing the constructability issues with the caisson installation may include the following.

- Compare the three different types of slices mentioned before by looking at each of their strength, durability, cost, constructability, and productivity.
- Ray Sowers with Office of Physical Plant will be a primary resource for completing the caisson rebar cage analysis.

- At least two different case studies will be used to complete this analysis; both having caissons with rebar cages, one using onsite fabrication, and the other using partial prefabrication.
- Compare the cost and schedule of splice types, fabrication techniques, and installation methods.

Expected Outcome

This analysis is expected to show that lap slices would be acceptable when fabricating the rebar cages for the caissons on the library project because lap slices are economical, do not require special tools, save time, save money, will have proper strength, and have an acceptable durability. If the design was altered to a more typical rebar cage layout, then prefabricated sections of the cages could be assembled off site and transported to site. These sections could be 5 feet in length to allow maximum flexibility while minimizing the requirement for field refabricating. Because these sections will be small, then a crane will not be needed to maneuver them into place, but rather a smaller piece of equipment could be used, such as an excavator. This analysis will positively influence the schedule and budget, while ensuring the structural stability of the building is not threatened.

Conclusions

This library in metropolitan Washington, D.C. has experienced delays through a number of different problems and loss of productivity scenarios. Causes of these delays have been determined and are the primary focus of the above discussed analyses. Innovative ways of benefiting the scheduled and eliminating the chances of potential delays is driving the construction industry. Topic 1 will act as an industry research topic in that it deals with improving the project delivery system. Topic 2, 3 and 4 are based on constructability challenges to accelerate the schedule. Overall, the values that are driving all these analyses are safety, relationship building, quality control, constructability issues, schedule management, budget control, and general project value added items.

Overall Breakdown

As seen below, the overall weight has been assigned to each of the four analysis topics and breath topics. Topics that have a breath in them will be worth more overall then topics with no breath. The industry research topic is to be worth 25% of the overall grade for the spring because it will involve in-depth research and information gathering to complete. Analysis topic two and three alone will be worth 20% of the grade because they will have to be tied into each of their respective breaths. Each breath topic will count as roughly 10% each because these are side analyses that must be done to fully analysis their main topics. Analysis topic four will be worth 15% of the overall grade because it will not be as in-depth as the other three analyses. Each of these topics relate to the proposed schedule that can be seen in *Appendix C*, in that the time scales approximately a line with the below percentages.

Grading Percentages for Analysis Assignments:

25% Research Topic- Early Involvement in Design (8 Weeks)

30% Analysis Topic #2- Structural Steel Sequencing (3.5 Weeks)

Redesign of Structural Steel Erection

Structural Breath- Erection Method Structural Analysis

30% Analysis Topic #3- Mechanical Penthouse vs. IPEC (3.5 Weeks)

Constructability Comparison of Systems

Mechanical Breath- Pump and Equipment Resizing

15% Analysis Topic #4- Caisson Rebar Cage Fabrication (3 Weeks)

Appendix A- Breadth Studies

Structural Breath Topic

As mentioned in Analysis Topic # 2, a structural breath will be incorporated in the structural steel erection sequence redesign that is outside of the construction management realm. This analysis lends itself to a structural breath because in reevaluating the sequence and methods used to erect steel for this project, multiple structural calculations may be required. In the option to assemble the cantilevered portion on the ground and rise it into place, this breath will include designing lifting points in the structure to ensure the structural stability of the frame during lifting and calculate the required lifting capacity of the crane. If shoring is to be used to support the cantilever, then this breath topic will include designing the shoring system along with its support system. As with any unknown structural erection method, similar structural stability calculations will be performed to check the feasibility of any and all options, like the ones mentioned above. In any case, the top priority will always be safety of the workers, general public, future users, and all involved in the project. This breath topic will strengthen Analysis Topic # 2, provide a more in-depth analysis, and take into account the structural reasoning of selecting a specific method.

Acoustical Breadth Topic

As mentioned in Analysis Topic # 3, an acoustical breadth topic will include that involves minor acoustical calculations to compare the sound and vibrations produced by an IPEC as compared to the mechanical penthouse option. This acoustical breadth analysis will tie nicely into past knowledge obtained in AE 309 (Architectural Acoustics). An acoustical study is particularly important for this building because the area designated for the IPEC or mechanical room will lie directly above the library, meeting space, and library administration offices. It is essential that noise and vibrations be minimized in these spaces. If the noise and vibrations produced from a mechanical penthouse are substantially more than the IPEC, then this could be the driving factor for keeping the IPEC design. The goal of this acoustical study is to ensure that the acoustical environment of the library and surrounding spaces are not compromised. A minimum allowable decibel level will be specified for the space under the mechanical space using references from AE 309. Then the estimated decibel level will be calculated in the mechanical space using manufacturer's specifications and equipment information sheets. Each type of mechanical room's floor and the library ceiling's transmission loss will then be determined or estimated. With the above information the decibel level in the library can be estimated and compared to the previously determined maximum allowable level. If this decibel threshold is not met in either one of the mechanical room options, then the assembly between the mechanical equipment and the library space will be altered to improve its' acoustical performance. However, the cost and schedule impact associated with this change will be calculated and added into the comparison already being performed in Analysis Topic #3 to determine which mechanical room option is the most feasible for this building.

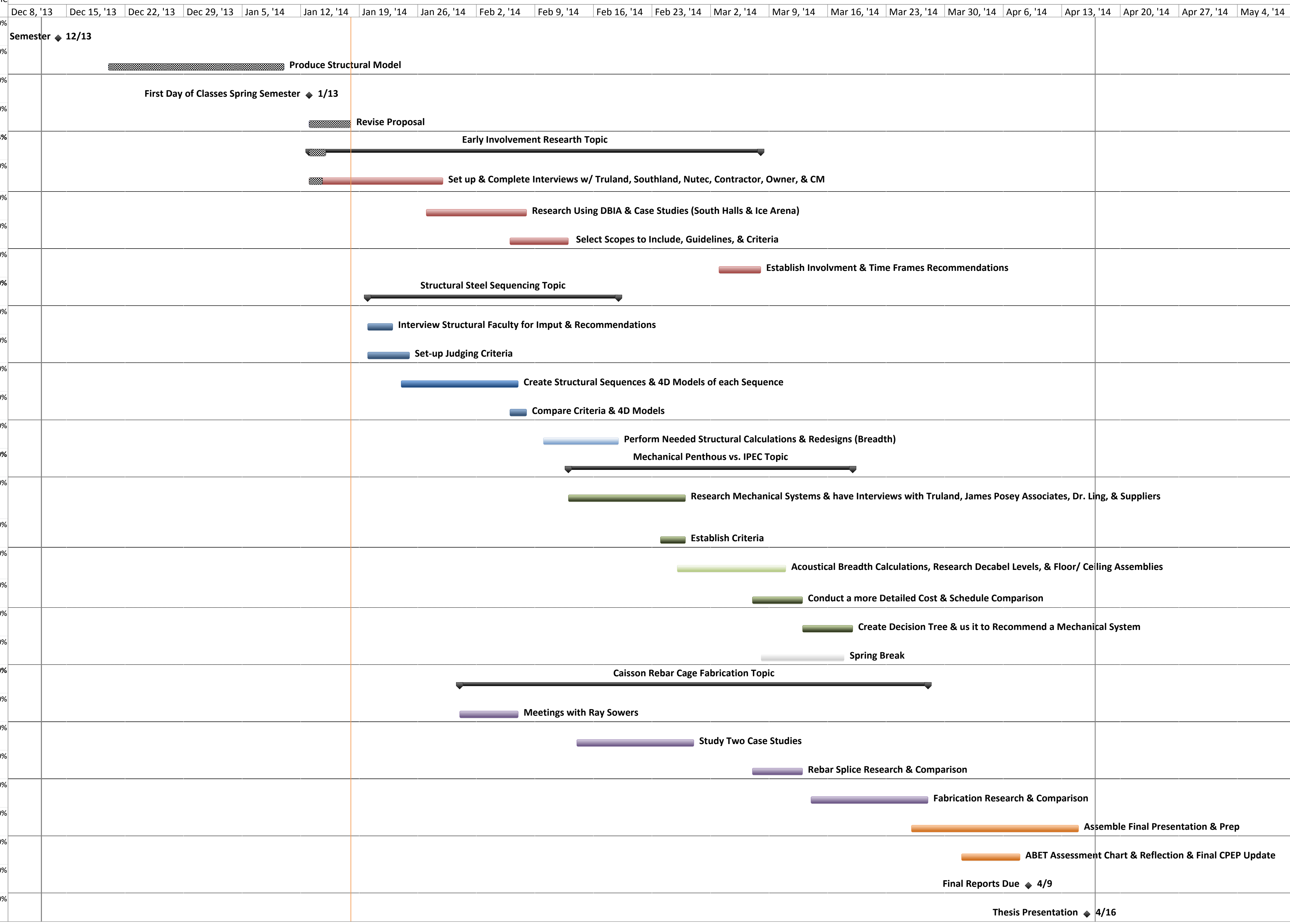
Appendix B- Typical Research Questionnaire

Typical Research Questions for Early Involvement

1. What kinds of projects do you normally see early involvement on?
2. In your option, what are the benefits of early involvement of contractors and specialty contractors?
3. What scopes have you seen that were involved in the design phase?
4. What are typical types of involvement or contractual obligations in design assist contracts?
5. What has been the level of owner involvement in these types of delivery methods?
6. Do you like design-build or design assist scenarios better? Why?
7. What are some examples of past work that should have used early involvement, and what are some examples that used it but should not have?
8. When is it ideal to bring on trades such as structural erection, curtain wall, mechanical, electrical, and plumbing?
9. How are the higher construction premiums that may result from early involvement justifiable?
10. Do you see more and more early involvement delivery methods being used in the future?

Appendix C- Proposed Spring Timeline

ID	Task Name	Duration	Start	Finish	% Comple
1	End of Fall Semester	0 days	Fri 12/13/13	Fri 12/13/13	100%
2	Produce Structural Model	15 days	Fri 12/20/13	Thu 1/9/14	100%
3	First Day of Classes Spring Semester	0 days	Mon 1/13/14	Mon 1/13/14	100%
4	Revise Proposal	5 days	Mon 1/13/14	Fri 1/17/14	100%
5	**Early Involvement Research Topic**	**40 days**	**Mon 1/13/14**	**Fri 3/7/14**	**4%**
6	Set up & Complete Interviews w/ Truland, Southland, Nutec, Contractor, Owner, & CM	12 days	Mon 1/13/14	Tue 1/28/14	10%
7	Research Using DBIA & Case Studies (South Halls & Ice Arena)	10 days	Mon 1/27/14	Fri 2/7/14	0%
8	Select Scopes to Include, Guidelines, & Criteria	5 days	Thu 2/6/14	Wed 2/12/14	0%
9	Establish Involvment & Time Frames Recommendations	5 days	Mon 3/3/14	Fri 3/7/14	0%
10	**Structural Steel Sequencing Topic**	**22 days**	**Mon 1/20/14**	**Tue 2/18/14**	**0%**
11	Interview Structural Faculty for Imput & Recommendations	3 days	Mon 1/20/14	Wed 1/22/14	0%
12	Set-up Judging Criteria	5 days	Mon 1/20/14	Fri 1/24/14	0%
13	Create Structural Sequences & 4D Models of each Sequence	10 days	Fri 1/24/14	Thu 2/6/14	0%
14	Compare Criteria & 4D Models	2 days	Thu 2/6/14	Fri 2/7/14	0%
15	Perform Needed Structural Calculations & Redesigns (Breadth)	7 days	Mon 2/10/14	Tue 2/18/14	0%
16	**Mechanical Penthous vs. IPEC Topic**	**25 days**	**Thu 2/13/14**	**Tue 3/18/14**	**0%**
17	Research Mechanical Systems & have Interviews with Truland, James Posey Associates, Dr. Ling, & Suppliers	10 days	Thu 2/13/14	Wed 2/26/14	0%
18	Establish Criteria	3 days	Mon 2/24/14	Wed 2/26/14	0%
19	Acoustical Breadth Calculations, Research Decabel Levels, & Floor/ Ceiling Assemblies	10 days	Wed 2/26/14	Mon 3/10/14	0%
20	Conduct a more Detailed Cost & Schedule Comparison	5 days	Fri 3/7/14	Wed 3/12/14	0%
21	Create Decision Tree & us it to Recommend a Mechanical System	4 days	Thu 3/13/14	Tue 3/18/14	0%
22	Spring Break	7 days	Sat 3/8/14	Mon 3/17/14	0%
23	**Caisson Rebar Cage Fabrication Topic**	**41 days**	**Fri 1/31/14**	**Thu 3/27/14**	**0%**
24	Meetings with Ray Sowers	5 days	Fri 1/31/14	Thu 2/6/14	0%
25	Study Two Case Studies	10 days	Fri 2/14/14	Thu 2/27/14	0%
26	Rebar Splice Research & Comparison	5 days	Fri 3/7/14	Wed 3/12/14	0%
27	Fabrication Research & Comparison	10 days	Fri 3/14/14	Thu 3/27/14	0%
28	Assemble Final Presentation & Prep	15 days	Wed 3/26/14	Mon 4/14/14	0%
29	ABET Assessment Chart & Reflection & Final CPEP Update	5 days	Tue 4/1/14	Mon 4/7/14	0%
30	Final Reports Due	0 days	Wed 4/9/14	Wed 4/9/14	0%
31	Thesis Presentation	0 days	Wed 4/16/14	Wed 4/16/14	0%



Project: Library in Metropolitan W
Date: Sat 1/18/14

Task | Split | Milestone | Summary | Project Summary

Submittal Date: 1-21-14