

Susquehanna Sports Center | Harford Community College | Bel Air, MD



# THESIS PROPOSAL

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12/14/2012

# Executive Summary

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The Thesis Proposal details the four analysis topics that will be performed during the spring semester for the Susquehanna Center Project. As a reminder, The Susquehanna Center Project consists of a renovation of 49,159 square foot and an addition of 58,640 square foot and costs \$26.7M. In the three technical assignments done during the fall semester the project was analyzed from a construction management perspective as a preparation for the core thesis analysis that will take place during the spring semester. The four chosen research topics are: 1) Weather impact on the foundation system schedule 2) Initiation of BIM in renovation projects 3) Alternative façade system 4) Commissioning mechanical systems in renovation projects.

The first analysis tries to analyze how weather impacts the construction of a foundation and how does that come into play in the scheduling process. Also, this research will help find how much does a construction team rely on weather forecasts and what techniques are used in order to prevent weather damages. That should reflect on the scheduling process and the duration of the respective tasks.

The second analysis will to find the best way to make this project eligible and make it feasible to use BIM. A study will be done in the most efficient ways to convert the documentation of the old building into a BIM friendly format. Also, it will aim to find how to go about educating other parties in the project about BIM and the importance of it in an efficient manner.

The third analysis's goal is to come up with a better alternative façade system and compare it with the old and current system to see what were the owner's different options were with the cost labeled in each option. This requires a value engineering study for the old and current façade systems and a new alternative façade system proposal which includes new architectural and structural designs.

The fourth analysis goal is to do a research on mechanical systems commissioning process in renovation projects and identify its most common issues. The common issues will be studied and taken into account while producing a generic commissioning process for renovation projects. It also aims to compile the issues that mechanical commissioners experience just like what happened in the Susquehanna Center project.

The Thesis proposal also includes an analysis weight matrix and a detailed schedule of when each component of the analyses will be performed during the spring semester. Also in appendix is a demonstration of where the breadth areas occur within the analyses performed.

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## Project Background

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The Susquehanna Center Renovation and Addition, Harford Community College in Bel Air, MD includes a renovation of the 49,159 square foot and a 58,640 square, which adds up to 106,955 square feet. Having a project that includes both a renovation and an addition required such a great collaboration and coordination between all parties involved in this project.

This project started construction on May 23<sup>rd</sup>, 2011 and was originally planned to finish on September 17<sup>th</sup>, 2012. However, due to weather related impacts, Turner has been granted a 38 working day extension for the Arena Addition. The addition part was then turned over beginning of November and the first basketball game was held November 15<sup>th</sup>. All the construction that is left to do as of the submission date of this proposal is the punch list and finishing up construction of the tennis courts. The Renovation portion of the project has not been affected by the weather impact and already was turned over on September 17<sup>th</sup>. The total cost of the project is \$26.7M after about \$1.65M worth of value engineering savings.

Figure 1 shows a view of both the renovation and addition parts of the project. The canopy of the façade is shown at the left and it extends till it reaches the basketball arena addition at the right, which has a greater height. The photo was taken during construction in early September.



**Figure 1: The facade's canopy of the Susquehanna Center is shown at the left, and the basketball arena addition is shown at the right. The photo was taken during construction in early September.**

## Project Background (cont'd)

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The new addition has 153' steel trusses that span through the new basketball arena addition. It has a beautifully designed curtain wall at the top portion of the walls, which increases the usage of natural light. The owner, Harford Community College, had a goal to make the campus more environmentally friendly and this is one the projects that they had in their master plan. They were originally planning on getting Silver LEED certification for this project. However, the owner decided not to strive for it right before construction started, but still the environment is one of the main components to care about in this project.

The project did go over some construction management issues which some of them were utilized in this proposal for the analyses. Other than the weather impact on schedule, the pool restoration was one of the main ones. The pool is over 30 years old and the owner wanted to completely restore it. The pool was tested beginning of September prior to installation of pool tiles and it turned out it was leaking. The site team was not surprised because for a pool this old, leakage is very possible. That caused a delay to the project as well.

Overall, the Susquehanna Sports Center is a great project for a construction management study as it contains both an addition and a renovation. That has been directly used in Analysis 2 and 4.

# Analysis 1: Weather impact on the foundation system schedule

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## **Problem Identification**

The project team has been granted a total of 38 working days as an extension mainly because of the rain impact on the foundation phase. The construction stopped as pouring concrete for footings was in the critical path. The scheduler for this project added 7 working days as a float, but it was not enough. After many discussions between the owner and Turner, they approved the extension. This topic will analyze the incident that happened in the project and see what could have been done differently in both preconstruction and construction phases in order to minimize or eliminate the delay.

## **Research Goal**

The goal of this research is to analyze how weather impacts the construction of a foundation and how does that come into play in the scheduling process. Also, this research will help find how much does a construction team rely on weather forecasts and what techniques are used in order to prevent weather damages. That should reflect on the scheduling process and the duration of the respective tasks. The Susquehanna Center will be taken as an example and as a basis for the research to be done on.

## **Background Research**

In order to initiate the research analysis, there has to be a background research done about weather impacts in foundation systems in the past. In addition, a research will be done on the physical construction techniques to avoid weather impact on foundations. Also, the history of those construction techniques and how they evolved will be helpful.

## **Methodology**

- ❖ Research about the construction techniques and strategies pursued to avoid weather impact and damages on the foundation phase
- ❖ Research and ask about the best ways to account for weather impact on a foundation system schedule
- ❖ Interview the project manager and get more details about the project schedule extension and ask about his opinion on the matter
- ❖ Find other examples of foundation schedule delays due to weather from fellow students
- ❖ Examine other examples and their scheduling process and do a comparison between them
- ❖ Meet with Dr. Anumba and other AE faculty members to talk about this topic throughout the spring semester and learn from their experiences

## Analysis 1 (cont'd)

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- ❖ Compile all the information gathered and try to come up with a better way that could have done to avoid the weather impact happened in the Susquehanna Center
- ❖ Use that to find a generic process that should be incorporated in the scheduling process to better account for weather impacts on foundation systems in future projects

### Resources and Tools

- Turner Construction project team: Project Manager and Project Executive
- Penn State Architectural Engineering faculty – Construction Management and Structure
- Project detailed schedule and estimate
- Project's construction documents
- Fellow 5<sup>th</sup> year AE students to find similar examples of project delays due to weather
- Applicable and reputable resources (books, websites, etc) about weather impact on construction activities

### Potential Solutions

In order to minimize the damage of weather in a foundation system, it needs to be analyzed from two different aspects: physical techniques and predicted schedule duration. The physical techniques are all the physical means possible to prevent the foundation system from any weather damages. During the background research, the most affordable and feasible techniques will be considered. All that should reflect on schedule as well, which is the second aspect that needs to be analyzed. Depending on the weather predictions and physical means used, a float will be added to foundation schedule activities. The task duration has to be just right, which is not too small that the project team has to deal with a delay if it went over the allocated duration, nor too large that it will take a much longer duration than desired.

### Expected Outcome

This research topic seems to have a great potential as weather could have a severe damage and it is sometimes underrated because extra weather precautions mean extra money and time spent. This research aims to provide affordable weather precautions that would prevent the majority of weather damages that could happen without having to pay heavily for advanced techniques or having to put very long floats on construction activities with a focus on foundation systems.

## Analysis 2: Initiation of BIM in renovation projects

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### **Problem Identification**

BIM was minimally used in the Susquehanna Center Project. One of the main reasons is the cost of using it. Although, it will pay itself in the long run and it will be worth it, it was decided not to use BIM. Being a donation dependent project is another factor. Despite the fact that BIM is now very widely spread in the building industry around the nation, some marketplaces lack the sufficient knowledge about it. So was the case with some subcontractors in this project. Moreover, since the existing building dates back to 1966, its documentation was not available in a format that would make the BIM process run smoothly.

### **Research Goal**

The goal of this research is to find the best way to make this project eligible and make it feasible to use BIM. A study will be done in the most efficient ways to convert the documentation of the old building into a BIM friendly format. Also, it will aim to find how to go about educating other parties in the project about BIM and the importance of it in an efficient manner.

### **Background Research**

In order to initiate the research analysis, there has to be a background research done about the process of BIM implementation in renovation projects. That includes finding examples of renovation project that implemented BIM, which could definitely have faced the same obstacles as the Susquehanna Center did. In addition, a research on the best ways to come up with the required BIM documentation is essential. That could be done by either converting the old construction documents or creating new as built construction documents.

### **Methodology**

- ❖ Research about the BIM implementation in renovation project
- ❖ Examine other examples of BIM in renovation projects
- ❖ Research about how BIM is executed when most of the parties lack BIM knowledge
- ❖ Study the best ways to bring BIM friendly CDs for renovation
- ❖ Interview the project manager and get more details about BIM in this project and how would he have implemented BIM if they had to
- ❖ Meet with AE faculty members to talk about this topic throughout the spring semester and learn from their experiences
- ❖ Compile all the information gathered and come up with a better way that could have done to implement BIM in the Susquehanna Center



## Analysis 2 (cont'd)

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- ❖ Use the info gathered to find a generic process for implementation of BIM in renovation project when most of the parties lack BIM knowledge and when CDs are not available in a good format for BIM

### Resources and Tools

- Computer Integrated Construction Research Program. (2009). "BIM Project Execution Planning Guide –Ver. 1.0." October 8, Penn State, University Park, PA, USA.
- Turner Construction project team: Project Manager and Project Executive
- Penn State Architectural Engineering faculty – Construction Management
- Project's construction documents
- Fellow 5<sup>th</sup> year AE students to find similar examples of renovation projects
- Applicable and reputable resources (books, websites, etc) about BIM and the respective topic

### Potential Solutions

A potential solution for this problem is 3D scanning surveying instruments. 3D laser scanning could be incorporated with BIM by scanning the building periodically and sending the information to a database accessible by the respective parties. Those tools could also be used to provide BIM friendly format of construction documents. That is of course to create CDs and models from scratch, but the available documentation for the old building could be used for verification. To ensure the feasibility of this solution, a cost analysis has to be done to it and see whether it could be actually used in the Susquehanna Center project.

As for how to implement BIM in a marketplace that lacks the knowledge of it, a planned coordination has to be done with all parties. This is a problem that comes across in a lot of the projects. It is difficult to bring subcontractors that all know BIM sometimes, and if they do, they might charge a lot extra. A potential solution for this would be to put some requirements for subcontractors in order to get awarded the job. Using a particular software program for drawings is one example. Early involvement with subcontractors especially those who do not use BIM is critical as well. All this could be labeled as different ways to coordinate with other parties in the project, but they need to be research and experimented in order to know whether they would work or not.

### Expected Outcome

By the end of this research, it is expected that it will provide a good guidance to contractors on how to implement BIM when it seems that there is no place for it in the project. This research also aims to help find the best and most up-to-date techniques for creating the required CDs and models for BIM.

## Analysis 3: Alternative façade system

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### Problem Identification

The façade of the existing Susquehanna Center has been completely redesigned and renovated which greatly impacted the structural system. The owner wanted a better looking facade than the fitness center brick wall and also wanted bigger windows to let more light in. He wanted all that for the lowest price possible. The fitness center was enclosed by a brick wall with small windows. By renovating it, it made the fitness center bigger using a curved shape curtain wall instead of the brick wall. In addition to the structural system, the mechanical and lighting systems were also affected. Although the owner was satisfied with the design, it was expected to be cheaper than this.

### Research Goal

The goal of this research is to come up with a better alternative façade system and compare it with the old and current system to see what were the owner's different options were with the cost labeled in each option. This requires a value engineering study for the old and current façade systems and a new alternative façade system proposal which includes new architectural and structural designs.

### Background Research

To start this research, both the old and current façade systems have to be completely understood along with the process of the architectural and structural system design in addition to its mechanical and lighting design. **Appendix A** includes a detailed demonstration of where the breadth studies occur within the discussed analyses.

### Methodology

- ❖ Study both the old and current façade systems
- ❖ Produce a cost and schedule analysis
- ❖ Study the building systems in the façade and its relationship to the building systems of the rest of the building
- ❖ Compare old and current facade systems
- ❖ Interview the Lead Designer and ask him about the process of the façade design, what other options they had,..etc
- ❖ Interview the Project Manager and ask about façade demo and construction issues
- ❖ Produce an alternative architectural designs for the façade where it meets the owner requirements but would cost less
- ❖ Design the structure required for the architectural design produced
- ❖ Do a cost and schedule analysis
- ❖ Produce a complete comparison between all three systems (old, current and alternative)

## Analysis 3: (cont'd)

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### Resources and Tools

- Turner Construction project team: Project Manager and Project Executive
- Hord Coplan Macht team: Lead Designer
- Penn State Architectural Engineering faculty – Construction Management and Structure
- Professor Holland and professors from the Architecture department
- Project's construction documents
- Façade's detailed estimate
- Applicable and reputable resources (books, websites, etc) about BIM and the respective topic

### Potential Solutions

Using the tools and resources above, it is possible to design an alternative façade system but it might not be better in all aspects considered. In all cases if the owner wanted to save money in the project, he/she is better off changing the design early than late, otherwise it would cost even more. This research analysis is here just to see what different options the owner had prior to construction and what the value engineering potential areas in this project are.

### Expected Outcome

Upon completion of this research, it is expected to have an alternative façade system design in hand. That would be compared with the old and current system to see what the different options the owner had in the beginning of the project.

## Analysis 4: Commissioning mechanical systems in renovation projects

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### **Problem Identification**

Testing and commissioning are both very critical in construction projects, and if not done correctly could lead to bad consequences. Susquehanna Center project is a good example of this. The main reason why the pool restoration took longer than anticipated in the Susquehanna Center project is the failure of the first test they had on the pool. The test was done while the pool tiles were not installed yet, so that they do not have to take off the tiles in case it fails. It turned out that the concrete and mortar on the pool had cracks and needs to be fixed before installing the tiles. This raises the question of the quality of the checks done prior to construction to help schedulers know the status of the pool. Testing the pool prior to construction is very essential here because the nature of the testing takes 2-4 weeks.

### **Research Goal**

The goal is to research mechanical systems commissioning process in renovation projects and identify its most common issues. Also, it will be attempted to create a generic process for commissioning mechanical systems in renovation projects. The common issues will be studied and taken into account while producing a generic commissioning process for renovation projects. It also aims to compile the issues that mechanical commissioners experience just like what happened in the Susquehanna Center project.

### **Background Research**

The process of commissioning of mechanical system has to be understood and then the same with the commissioning process for mechanical systems in renovation projects. Also, the history of commissioning and the different experiences that commissioning agents went through will definitely be a good start for this research.

### **Methodology**

- ❖ Research the process commissioning for mechanical systems in general
- ❖ Research commissioning for mechanical systems in renovation projects
- ❖ Study the mechanical system of the building and its commissioning process
- ❖ Interview the project manager and the mechanical contractor and get more details about the process of commissioning in the project
- ❖ Meet with AE faculty members to talk about this topic throughout the spring semester and learn from their experiences
- ❖ Compile all the information and findings
- ❖ Use that to find a generic process for mechanical systems commissioning in renovation projects

## Analysis 4 (cont'd)

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### **Resources and Tools**

- Turner Construction project team: Project Manager and Project Executive
- Burdette, Koehler, Murphy & Associates, Inc, (MEP contractor for the project)
- Penn State Architectural Engineering faculty – Construction Management and Mechanical
- Project's construction documents
- Fellow 5th year AE students
- AE 476: Building Construction Management II course
- Applicable and reputable resources (books, websites, etc) about mechanical systems commissioning in renovation projects

### **Potential Solutions**

Early involvement and coordination in the projects prevents many potential problems, so does commissioning. That is why they have to come so early in the project as early as pre-design starts, and they are one of the last people to leave the site after it is finished.

However, the main solution or outcome that this research is moving towards is a definition of the commissioning process for renovation projects. That definition could work as tips and recommendations for commissioners based on previous commissioning experiences in renovation projects.

### **Expected Outcome**

The main expected outcome of this research is a commissioning process dedicated to renovation projects like the Susquehanna Center project. The research is also expected to help gather a compilation of commissioning experiences in renovation projects and how did the team overcome it.

## Analysis Weight Matrix

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The table below illustrates the amount of time and emphases that will be allocated among the four analysis areas during the spring semester. A detailed schedule for the research that will occur during the spring semester is attached in **Appendix B**.

#	Analysis	Critical Issue Research	Value Eng.	Constructability Review	Schedule Acceleration	Total
1	Weather impact on the foundation schedule	15%	5%	5%	15%	30%
2	Initiation of BIM in renovation projects	15%	5%	-	10%	30%
3	Alternative façade system		10%	5%	5%	20%
4	Testing and commissioning mechanical systems in renovation projects	10%	-	-	-	10%
	<b>Total</b>	<b>40%</b>	<b>20%</b>	<b>10%</b>	<b>30%</b>	<b>100%</b>

In conclusion, the four analysis topics chosen for research during the spring semester seem to have big potential. They were all chosen based on the information gained after the construction management research conducted during the 3 technical assignments. In addition, the PACE roundtable meeting helped generate new ideas and relate the current construction industry issues to what the 5<sup>th</sup> year AE students have seen in their projects.

## Appendix A: Breadth topics:

### **Architectural Breadth**

Analysis 3, Alternative façade system, includes an architectural breadth as it is needed to redesign the façade system to propose an alternative façade system. The process will be first studying the old and current façade systems, where it will be looked at from an architectural point of view, and what the key architectural features that have been changed. Next, the lead designer will be interview and asked about the actual design process of the façade. After that, all the information gained will be gathered and taken into account while designing the façade.

### **Structural Breadth**

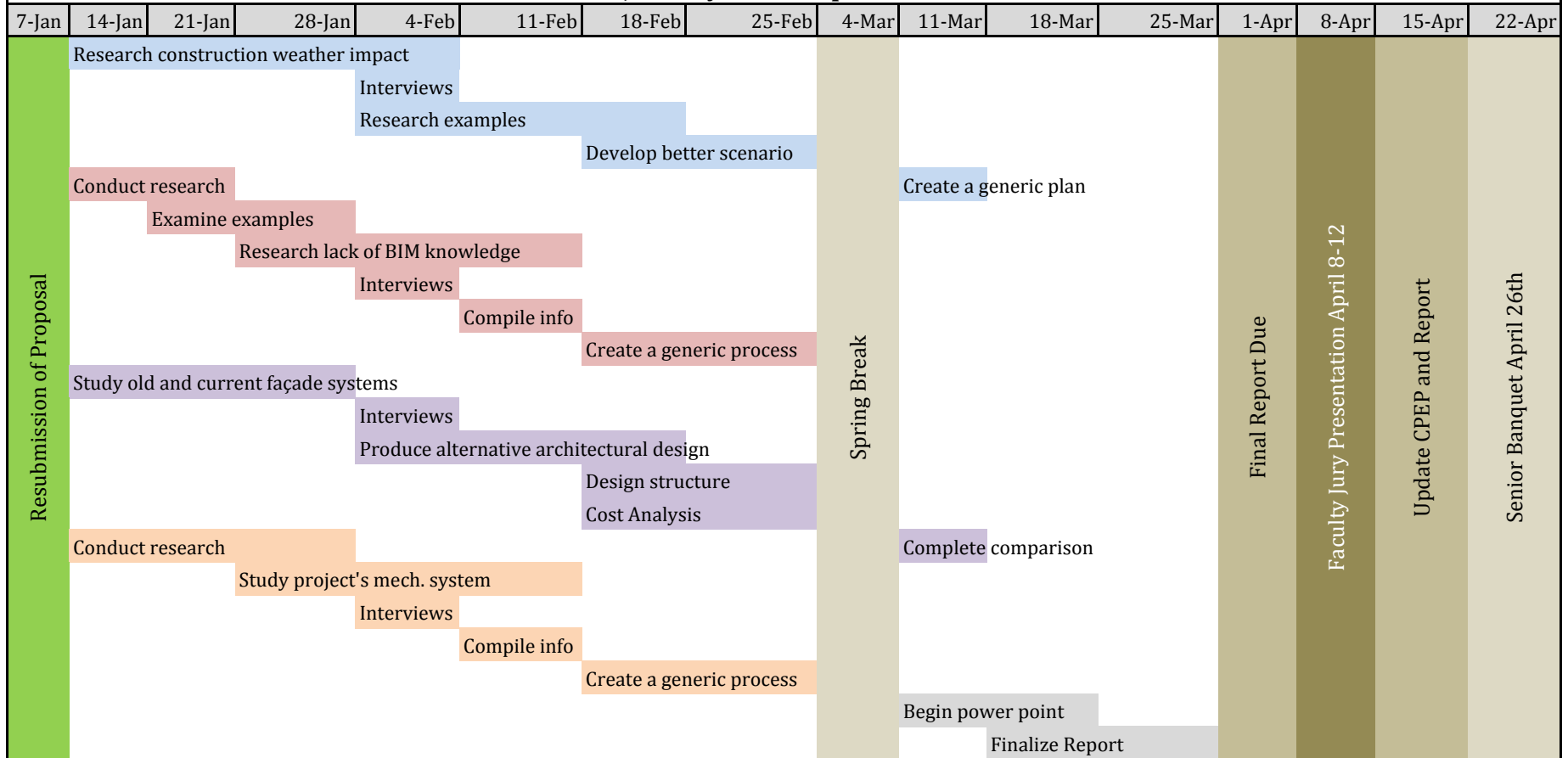
Also included in Analysis 3 is a structural breadth. While designing the façade, the structure will be thought about as well. One of the main reasons to redesign the façade is to look at cheaper and other options, so it will be attempted to save money through the structural design. One of the options would be using the same structural materials as the basketball arena addition.

### **Mechanical Breadth**

Analysis 4 will include a mechanical breadth as it deals with commissioning mechanical systems. It does not necessarily involve a mechanical design, but it does require a mechanical knowledge and a background of how the mechanical systems work in the Susquehanna Center. It is also inevitable to study the electrical and plumbing systems of the building. The goal of the Analysis 4 is to create a generic process for mechanical commissioning in renovation projects. Whether it is specific enough to create a generic process or not, it would be essential to use the mechanical design the project with information from external sources about mechanical commissioning in renovation projects.

	1/28/2013 Milestone 1		2/11/2013 Milestone 2		3/1/2013 Milestone 3		3/26/2013 Milestone 4	Haitham Alrasbi Advisor: Dr. Chimay Anumba Submitted: 12/14/12	
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**Proposed Thesis Spring Semester Schedule  
January 2013 - April 2013**



<b>Legend</b>	Analysis 1: Weather impact on the foundation system schedule	<b>Milestones</b>	(1) 1/28/2013 - Research Complete
	Analysis 2: Initiation of BIM in renovation projects		(2) 2/11/2013 - Interviews Complete
	Analysis 3: Alternative façade system		(3) 3/1/2013 - Core Analysis Complete
	Analysis 4: Commissioning mechanical systems in renovation projects		(4) 3/26/2013 - All Content Complete