GOVERNMENT OFFICE CENTER
MID-ATLANTIC U.S.

SENIOR THESIS FINAL PROPOSAL

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EXECUTIVE SUMMARY

This report is designed to present the four analyses that will be conducted as part of the final thesis report on the Government Office Center renovation and modernization project. In combination, the analysis topics will offer insight into a fundamental theme of the importance of active owner involvement to the success of a construction project.

Analysis #1: Implementation of Building Information Modeling

The construction team faces the unique challenge of finding a way to properly install new mechanical equipment and tie the new equipment into existing system duct and piping. Work must follow a defined tenant phasing plan that will allow the building to remain occupied throughout the construction process. Also, although this project will significantly impact future facilities management efforts, very little information is being pushed downstream through BIM to support the needs of facilities management staff. The goal of this analysis is to evaluate the benefits of implementing BIM for field and facilities management purposes.

Analysis #2: SIPS Study for Curtain Wall Activities

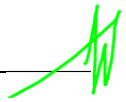
Since a major portion of the scope of this project involves the highly repetitive process of replacing the curtain wall systems, the project schedule can be directly reduced through the implementation of Short Interval Production Scheduling. The goal of this analysis is to quantify the benefits of implementing SIPS for the activities that make up this demolition and replacement process. This analysis will also incorporate an electrical breadth study through evaluation of the feasibility of an alternate building-integrated photovoltaic curtain wall system.

Analysis #3: Integrated Processes

As the construction industry moves toward more integrated solutions to unique and complex project delivery challenges, the teams that face these challenges would benefit from the identification of the traits that define an engaged owner, as well as the identification of the process and integration failures that can plague a high performance retrofit project. The goal of this analysis is to draw themes from the experiences of industry professionals and evaluate the impact of these failures on the delivery of systems critical to high performance retrofit projects.

Analysis #4: Progressive Collapse

The Government Office Center will eventually require structural upgrades to meet the federal requirements for progressive collapse prevention that were implemented decades after the original construction of the building. The goal of this analysis is to analyze the cost and schedule impacts of adding a progressive collapse system to the scope of this renovation project or a future project. This analysis will also incorporate a structural breadth study through the partial design of a theoretical section of this system.



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PROJECT BACKGROUND

The Government Office Center is a modernist high-rise originally designed and constructed in the mid-1970s, and is essentially a rectangular building with sides facing nearly North, South, East, and West. The East and West facades are a uniform tan brick from top to bottom, without any breaks for windows. The North and South facades are large glass curtain walls spanning almost the entire building height, allowing relatively uniform diffuse daylight to enter the building from the North while more intense and direct sunlight enters the building from the South.

The first three floors contain courtrooms and rooms that serve functions relating to courtroom activities. The remainder of the building contains the offices, file storage, IT spaces, and other functions needed to serve an office building of this size. Due to the nature of the core functions of the Government Office Center, the construction process must allow the building to remain fully occupied and operational for the duration of the project. Therefore, significant coordination must be in place in order to ensure that building occupants, files, and furniture are appropriately relocated to allow demolition and construction activities to take place while minimizing the impact on ongoing functions within the building.

The existing curtain wall on the North and South facades will be replaced with a unitized, aluminum-framed curtain wall assembly. The intent of this portion of the renovation is to offer drastic improvement to the thermal performance of the building envelope, which in turn reduces the demand on the mechanical systems of the Government Office Center. During this project, a temporary engineered weather wall, as illustrated in Figures 1 and 2, will separate the work zone from the occupied building areas. The existing system will then be removed on a specific floor, working from top to bottom. A material hoist on the Northwest corner of the building will allow for the transfer of materials and large waste products into and out of the building.

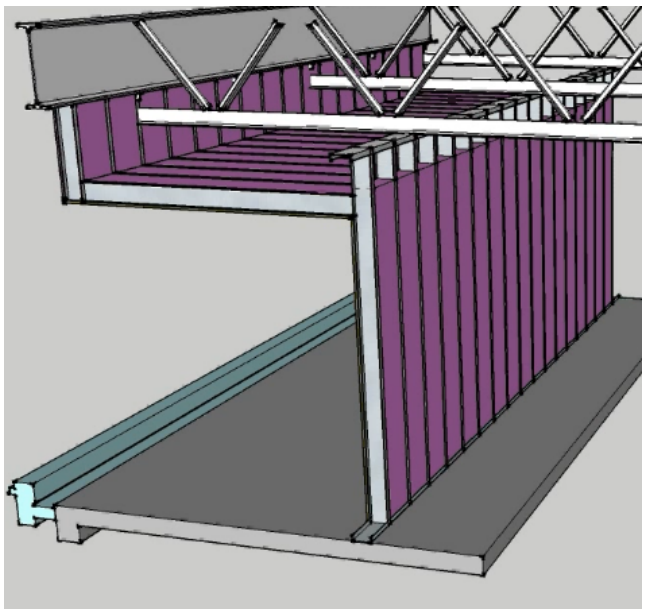


Figure 1: View of Temporary Weather Wall Under Construction

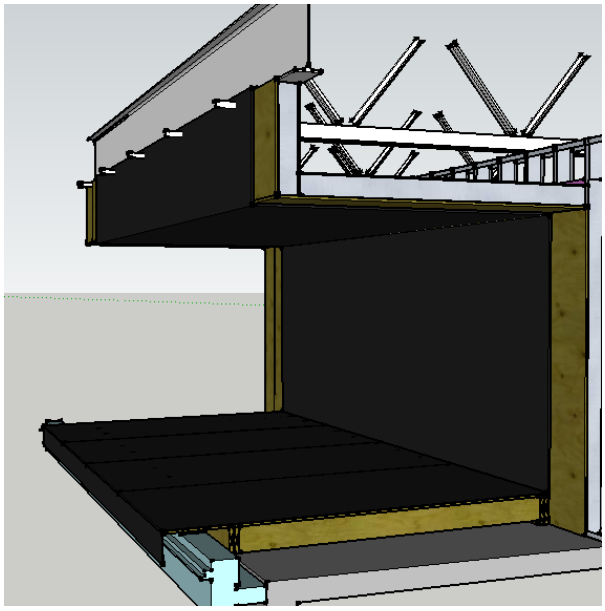


Figure 2: Virtual Mockup of Completed TWW Segment

Mechanical rooms are located on the 1st and 14th floors. Air handling units present in the Government Office Center will be replaced and improved through the addition of variable flow valves. Existing perimeter electric baseboard heating will be replaced with VAV boxes with hot-water reheat that will distribute to new perimeter slot diffusers. The existing cooling tower and chillers will be replaced and converted to variable primary flow. Also, existing boilers will be replaced with more energy-efficient natural gas-fired boilers.

After review of the Government Office Center renovation project, discussions with members of the project team, and interactions with industry members at the PACE Roundtable, several potentially problematic aspects of this project were identified for analysis as part of future research. Challenges involving the difficulty of tying into existing mechanical systems, as well as the limited information flow to the owner for facilities management purposes, suggest that great value can be found through the implementation of BIM in the field and for facilities management. The highly repetitive nature of curtain wall demolition and replacement activities lend themselves to the implementation of production management controls like SIPS. Also, because this building was constructed decades before federal progressive collapse requirements were put in place, the Government Office Center will require significant structural upgrades to meet these requirements. Most importantly, the role of the owner in successfully completing a high performance retrofit project is extremely important, and may have had measurable impacts on the end result of this project.

ANALYSIS #1: IMPLEMENTATION OF BUILDING INFORMATION MODELING

Problem Identification

Due to the unique challenges that face the Government Office Center renovation project, the construction team must find a way to properly install new mechanical equipment and tie the new equipment into existing system duct and piping. Since the building will remain occupied for the duration of the construction process, work must also proceed according to a tenant phasing plan that will relocate tenants and file cabinets to create isolated and safe work areas. In addition, although the scope of this project will significantly affect building operations and facilities management in the future, surprisingly little has been done to push information downstream through BIM for the benefit of facilities management staff.

Research Goal

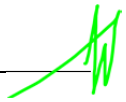
The purpose of this analysis is to evaluate the benefits of implementing Building Information Modeling (BIM) for use on site during the construction process and as a means to meet the needs of the owner during program development and as a useful facilities management tool.

Methodology

- Contact Balfour Beatty Construction for data on current methods of on-site location of information, as well as desired improvements to these methods
- Contact GSA for information on how their facilities are managed
- Interview other owners of substantial property to identify themes
- Interview software developers for information on how BIM can be brought to the field
- Identify and choose options that can bring existing BIM work into the field
- Analyze impacts of selected field BIM implementation methods
- Draw conclusions based on the application of field use of BIM to support construction efforts impacted by existing mechanical systems and tenant phasing requirements
- Develop virtual mock-up of a key building area for program development purposes
- Develop virtual mock-up to meet previously identified facilities management needs
- Analyze virtual mock-ups for added value per added cost
- Develop a summary of how an owner can benefit from leveraging BIM

Resources and Tools Needed

- Industry Professionals
- Applicable literature
- AE 597F (Virtual Facilities Prototyping) information
- Balfour Beatty Construction project team – data on current methods and desired improvements
- GSA – information on facilities management needs
- Software developers – information on BIM use on tablets or at field stations
- Computer software for development of virtual mock-ups



Expected Outcome

This analysis should quantify the benefits associated with meeting the needs of the project team and the owner regarding some of the unique aspects of the Government Office Center project. Evaluated methods of implementing BIM in the field will show how improved availability of this information adds value to the construction process. This improvement will be illustrated as a benefit to the construction team through reduction of waste in schedule time while searching for information, as well as cost savings through earlier identification of issues.

Analysis of owner needs will show how minimal expansion to existing BIM efforts improves the flow of information from concept to turnover, with observable benefits during program development and facilities management. Virtual mock-ups will be generated based on the needs derived from discussions with owners, and will be evaluated to determine whether these program development and facilities management needs can be met through BIM.

ANALYSIS #2: SIPS STUDY FOR CURTAIN WALL ACTIVITIES

Problem Identification

The replacement of the North and South curtain wall systems constitute a substantial portion of the scope of this project and fall on the critical path of the schedule. Because of the highly repetitive nature of the construction activities relating to the curtain wall replacement, the project schedule could benefit from the implementation of a production management technique such as Short Interval Production Scheduling (SIPS). Additionally, the replacement of the South-facing curtain wall provides an excellent opportunity to incorporate a building-integrated photovoltaic system into the scope of this project. In this case, the owner would stand to benefit by challenging the project team to increase the value of the project without increasing cost or duration.

Research Goal

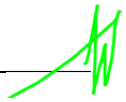
The purpose of this analysis is to evaluate the benefits of incorporating SIPS for a substantial portion of the project scope and to evaluate the feasibility of an alternate building-integrated photovoltaic curtain wall system.

Methodology

- Identify key activities that relate to the demolition and replacement of the curtain walls
- Interview construction team for an understanding of activity durations and other details
- Interview PV glazing manufacturers and installers for details regarding cost, schedule, and performance of the proposed alternate system
- Develop SIPS model based on insight gained from interview process
- Analyze feasibility and constructability of alternate PV curtain wall system
- Draw conclusions based on whether implementation of SIPS for curtain wall activities would benefit the project
- Draw conclusions based on whether the proposed alternate PV glazing system is financially feasible and whether it impacts the planned construction sequence
- Develop a summary of findings illustrating the benefits of SIPS and PV glazing compared to necessary effort involved

Resources and Tools Needed

- Industry Professionals
- Applicable literature
- AE 570 (Production Management in Construction) SIPS information
- Balfour Beatty Construction project team – data on activities as planned
- PV glazing manufacturers and installers – data on cost, performance, and construction process
- William McDonough + Partners – perspective on proposed alternate PV glazing
- Greenman-Pedersen, Inc. – information on impact of solar thermal load due to alternate PV glazing system



Expected Outcome

This analysis is expected to demonstrate the benefits of optimizing work activities through the use of a SIP schedule. Implementation of the SIPS method for this set of highly repetitive activities should reduce required schedule time, which in turn will reduce the overall project duration. Schedule savings provide value by reducing total general conditions needed and by allowing earlier turnover to the owner.

While the addition of a photovoltaic curtain wall may initially suggest a cost and schedule overrun, this analysis should demonstrate that it can be a viable option to add value for the owner. Because the existing system will already be replaced as part of the modernization plan, only the marginal cost of the transparent or translucent solar array needs to be financially justified. A constructability review will ensure that this system can be installed without detriment to the project schedule.

ANALYSIS #3: INTEGRATED PROCESSES

Problem Identification

The construction industry is slowly beginning to trend toward more integrated solutions to project delivery challenges. Designers, contractors, and owners are forming teams in order to improve value while reducing wasted time and money along the way. For the greatest chance of success, owners must be fully engaged in the process from concept to turnover. Integrated teams would benefit from the identification of the traits that define an engaged owner that positively contributes to integrated team efforts, as well as the identification of the process and integration failures that can be encountered on this type of project.

Research Goal

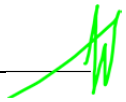
The purpose of this analysis is to evaluate process and integration failures associated with disciplines like envelope and mechanical systems that are critical to the success of high performance retrofit projects.

Methodology

- Interview industry professionals regarding the benefits of an engaged owner
- Evaluate themes and identify key traits of engaged owners who positively contribute to integrated team efforts
- Interview project team members to gain an understanding of the management of the design and procurement process
- Interview industry professionals regarding envelope and mechanical systems in high performance retrofit projects
- Evaluate themes and identify specific causes of failures associated with the critical systems in high performance retrofit projects
- Draw conclusions based on the benefits of an engaged owner on the delivery of envelope and mechanical systems in high performance retrofit projects
- Analyze how these conclusions could apply to the Government Office Center in terms of accelerating the design schedule, improving constructability of the curtain wall and mechanical equipment, and ensuring that the needs of the owner are met

Resources and Tools Needed

- Industry Professionals
- Applicable literature
- AE 572 (Project Development and Delivery Planning) IPD information
- Project team members involved in design and procurement process
- Case studies of high performance retrofit projects (preferably with similarities to the Government Office Center renovation)



Expected Outcome

This analysis is expected to provide insight into the importance of owner involvement throughout the project delivery process. In particular, this analysis will identify and evaluate the effect of a positively engaged owner on critical systems in high performance retrofit projects. Benefits should include design schedule acceleration, improved constructability, and an overall better product delivered to the owner. In fact, although the Government Office Center is not considered a high performance retrofit project, this analysis may demonstrate that improved owner involvement could have led to an end result with greater performance under the same budget and schedule constraints.

ANALYSIS #4: PROGRESSIVE COLLAPSE

Problem Identification

The federal government implemented progressive collapse prevention requirements for government buildings decades after the original construction of the Government Office Center. As a result, the building will eventually require structural upgrades to meet these regulations. Considering the need to maintain continuous occupancy during the current renovation project, it can be assumed that the installation of the progressive collapse prevention mechanisms will face the same constraints. Although these constraints would likely impact the cost and time needed to complete the work, the impact could perhaps be mitigated if this system is installed as part of the scope of the current renovation project.

Research Goal

The purpose of this analysis is to analyze the cost and schedule impacts of adding a progressive collapse system to the scope of this renovation project as compared to incorporating this system into a future project.

Methodology

- Develop a working knowledge of the basics of progressive collapse prevention methods used in retrofit projects
- Design a theoretical section, such as a column or bay
- Determine total material and labor requirements by extrapolating the designed theoretical section as necessary across the building
- Analyze the cost and schedule impacts of installing this system separately, during the current renovation project, or during a future renovation project, as well as the implications of each choice
- Determine the value of having this system

Resources and Tools Needed

- Industry Professionals
- Applicable literature
- AE Structural students
- Thornton Tomasetti – information on progressive collapse systems

Expected Outcome

This analysis should demonstrate that a progressive collapse prevention system should be installed as part of the scope of a major renovation project, due to the impact on building occupants during the construction process. In addition to inflation, other factors will likely be identified that suggest installing this system during the current renovation project is more beneficial than waiting for the next major renovation project. However, the addition of this system will increase the cost and construction duration beyond what is currently planned.

ANALYSIS WEIGHT MATRIX

As shown in Table 1 below, the weight matrix demonstrates how each of the four analyses will be divided in terms of overall effort and core areas of investigation. The listed percentages are estimates of the expected time and effort that will be applied towards achieving goals in the areas indicated.

Description	Research	Value Engr.	Constr. Rev.	Sched. Accel.	Total
BIM	15%	-	5%	-	20%
SIPS	-	10%	10%	15%	35%
Integration	15%	-	5%	5%	25%
Prog. Collap.	-	10%	5%	5%	20%
Total	30%	20%	25%	25%	**100%**

Table 1: Weight Matrix for Distribution of Core Areas of Investigation

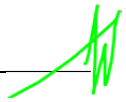
TIMETABLE

In an effort to manage the tasks required to successfully complete this thesis project, a preliminary timetable has been developed to illustrate the planned workflow for each technical analysis. See Appendix B for the spring semester preliminary timetable.

CONCLUSIONS

After the completion of thorough analyses described previously, industry professionals will have access to insight into the importance of an engaged owner, especially as it relates to the success of a high performance retrofit project. Greater owner involvement in the project delivery process would benefit projects like the Government Office Center by supporting program development and defining the future needs of facilities management staff. Implementation of SIPS for the curtain wall activities may provide the needed savings to justify the addition of a building-integrated photovoltaic curtain wall system. Identification of traits that define positively engaged owners as well as the identification of process and integration failures that negatively impact the delivery of critical systems of high performance retrofit projects would benefit the members of the industry who are pushing forward in this direction. Finally, while the Government Office Center will eventually require structural upgrades to meet federal progressive collapse requirements, an engaged owner may have been able to justify its inclusion in the current renovation project as opposed to a future renovation that may be upwards of thirty years away.

Note: This proposal is intended to be a work-in-progress that will evolve based on feedback from thesis advisors.



APPENDIX A – BREADTH TOPICS AND MAE REQUIREMENTS

BREADTH TOPICS

The topics listed below describe more in-depth analyses in other technical disciplines within the major. Each of the topics described ties directly to previously proposed analysis ideas, and is identified accordingly.

Renewable Energy/Electrical Breadth: Contributes to Technical Analysis #2

The current curtain wall system that will replace the original façade does not have photovoltaic properties. The proposed alternate system is a transparent or translucent curtain wall system that acts as a photovoltaic electricity generator for the building. This system is only proposed for the South curtain wall, due to the amount of exposure to direct solar radiation that it will receive.

This breadth analysis will examine the necessary equipment and other details pertaining to the impacts of choosing this system over the current curtain wall replacement. Adding renewable energy into the financial equation helps to justify the increase in total system cost incurred by this proposed alternative. Also, reduction in schedule time due to the implementation of SIPS (refer to Analysis #2) may account for any remaining negative impacts to cost or project schedule that have not been justified through electricity production.

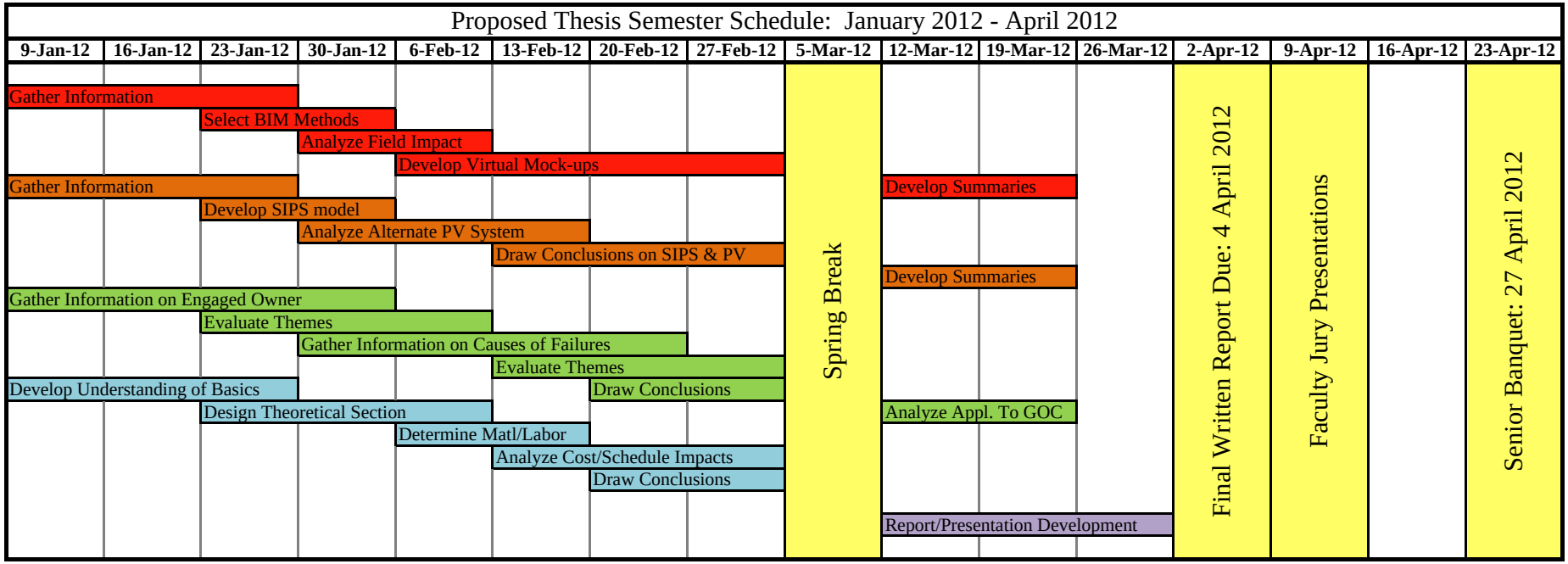
Structural Breadth: Contributes to Technical Analysis #4

The implementation of a progressive collapse prevention system will require substantial structural renovation work. As a result, this system must be appropriately designed such that it can be evaluated for cost and schedule impacts. Therefore, this breadth analysis will require the design of a theoretical section of this system that will be extrapolated across the building and that will allow for proper evaluation of cost and schedule impacts that will be incurred when this system is eventually installed.

MAE REQUIREMENT

The MAE requirements of this thesis project will be accomplished through the BIM implementation analysis, SIPS study, and the integrated processes analysis. Methods learned in AE 597F (Virtual Facilities Prototyping) will be applied to the development of models for facilities management purposes. Concepts from AE 570 (Production Management in Construction) will be applied to the implementation of SIPS for activities relating to the curtain wall demolition and replacement. Finally, information from AE 572 (Project Development and Delivery Planning) will support research efforts that evaluate integrated teams and their needs.

APPENDIX B – SPRING SEMESTER PRELIMINARY TIMETABLE



Milestone 1 : 27 January 2012	Collect Necessary Data & Begin Analysis Efforts
Milestone 2: 13 February 2012	Complete First Half of Analysis Efforts
Milestone 3: 2 March 2012	Complete Second Half of Analysis Efforts
Milestone 4: 26 March 2012	Complete Summaries and Application to GOC

- Analysis #1: Implementation of Building Information Modeling
- Analysis #2: SIPS Study for Curtain Wall Activities
- Analysis #3: Integrated Processes
- Analysis #4: Progressive Collapse