

# Thesis Proposal

Friday, December 12, 2008



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Construction Management Option  
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**Constitution Center**

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## CONSTRUCTION MANAGEMENT OPTION

# CONSTITUTION CENTER

## 400 7TH STREET SE, WASHINGTON, DC 20024



### BUILDING STATISTICS

- Size: 1,500,000-SF base building and 600,000-SF parking garage
- Number of Stories: Three-level underground parking garage, 10 stories + Pent House
- Occupancy Type: Class A Office Space
- Cost: \$246 Million GMP
- Construction Dates: July 2007 - November 2009
- Delivery Method: Design-Bid-Build
- LEED Gold Project



### MECHANICAL & ELECTRICAL

- Centralized Plant in the Penthouse Housing:
  - Two 800 h.p. Boilers
  - One 350 h.p. Boiler
  - Three 1200 ton Trane Chillers
  - Eight 30,000 CFM Trane Air Handlers
  - Eight 30,000 CFM Semco Energy Recovery Units
  - Four 1200 ton Cooling Towers utilizing 6,700 Active Chilled Beams
- Power distribution system of 13.8 kVA feed from four primary switchgear connected to Pepco feeders
- 10 secondary 4000A transformers within the garage and Pent House levels
- Two 1000 kilowatt generators are roof mounted to provide power back-up to the critical building systems during a power outage
- Two dedicated chiller/purifier drinking water systems that continuously circulate water throughout the building
- Custom made Chilled-Beam System from Germany

### PROJECT TEAM

- Owner/Developer: David Nassif Associates
- General Contractor: James G. Davis Construction Corporation
- Owners Representative: Kramer Consulting
- Architect: SmithGroup, Inc.
- MEP Engineer: SmithGroup, Inc.
- Civil Engineer: Wiles Mensch Corporation
- Structural Engineer: SK&A

### STRUCTURAL

- Precast panels found at all four corners of the building, which frame the spandrel glass
- Blast resistant curtainwall throughout at Streetscape and Courtyard, with floor two being the most resistant including an air barrier system
- Metal panel on the Pent House level to conceal the MEP equipment
- Blast protection in garage tenant space, entrance ramp, internal ramps, electrical rooms, telecom rooms, elevator shafts, egress stairs, and exposed columns
- Two-way waffle slab on all floors except the Pent House

### ARCHITECTURE

- Renovation of an existing building, originally constructed in 1976 and occupied by the Department of Transportation (DOT)
- 4 separate, but integrated quadrants that have their own elevator, stairs ways, bathrooms, electrical closets, communication closets
- One acre of courtyard that is a private, secure green space with fountain, seating areas, sculpture, and 32 Honey Locust Trees that are 11'-15' tall
- White Marble and Jerusalem Limestone are located around the first level of the building, creating a boarder for the spandrel glass located at the storefront entrances
- Built-up roofing system and metal panels used to conceal the MEP equipment on the Pent House level



RENDERINGS PROVIDED BY SMITHGROUP, INC. AND STUDIO CHRISTEN

## EXECUTIVE SUMMARY

The following proposal contains information about the research that will be conducted during the spring semester. This research will be based off of four analyses that pertain to the construction of Constitution Center. There are four analyses that will be outline include the chilled beam systems, curtain wall installation, structural integrity of the parking garage, and pedestrian safety.

### Analysis 1:

The first analysis deals with the chilled beam system being installed. This is the largest system being installed in the United States and provides an area to gain knowledge to a system that may become widely used in future buildings. This analysis also provides an area for a critical industry research and a mechanical breadth. Both of these topics will deal with the commissioning requirements for Constitution Center.

### Analysis 2:

The second analysis incorporates the MAE Graduate-Level component of *CE 533 - Construction Productivity Analysis and Performance Evaluation*. The research would focus around the curtain wall installation procedures and how they impact both the schedule and the site logistics.

### Analysis 3:

The third analysis incorporates a structural breadth for a redesign of the parking garage waffle slab. During the renovation process, quadrants of the parking garage were completely shut down in order for the floors to be updated. The redesign will focus on a two-way reinforced concrete system and a flat plate, drop panel with column capitols.

### Analysis 4:

The final analysis will study the safety requirements for the pedestrians about Constitution Center. Since the L'Enfant Metro Station Entrance was within the construction site, it was a problematic feature to keep the pedestrians safe, but not limiting the use of the metro or the work taking place on the construction site. This research will also be studying a critical industry issue and will allow for the expansion of knowledge in a field that is very important on every construction site.

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## ANALYSIS DESCRIPTIONS

### *Analysis 1: Critical Issue Research Method - Chilled Beam System*

#### **Problem/Opportunity Statement**

The chilled beam system being installed into Constitution Center started as a construction management issue due to the size of the plenum space. This system was then redesigned in order to fit into the space and utilize a system that is widely used in Europe. The chilled beams provide an opportunity for research in a field that is increasing in the United States. This research will allow for increased knowledge of the system, along with an understanding on why the project team decided upon the system. The chilled beam system also allows for the evaluation of how the system affects cost, schedule, and site logistics. Finally, this system presents a construction management issue that can be incorporated into a mechanical breadth.

#### **Mechanical Breadth**

While analyzing the chilled beam system, the chance to evaluate the commissioning requirements for the mechanical systems will provide an opportunity for a mechanical breadth as well as a critical industry issue. With a project the size of Constitution Center, the commissioning requirements are very detailed. After evaluating the requirements, if necessary an updated or new system of tracking the commissioning will be proposed.

#### **Research Steps**

1. Travel to Atlanta, Georgia to TROX USA, Inc. in order to see firsthand how the chilled beam systems, both passive and active, work. The CEO & President has activities planned to provide me with an understanding of how the system works in order to continue my research.
2. Return to Constitution Center to become familiar with the installation requirements and storage limitations of the chilled beams. While there, I will also be able to capture construction photos of the chilled beams in both the marketing space and the DAVIS conference room.
3. Evaluate publications of the chilled beams. Currently I have access to numerous articles and plan to incorporate them into my research.
4. Interview the DAVIS project team in order to see how the schedule, cost, and site logistics were affected by the chilled beam systems.
5. Interview SmithGroup to find out why they chose the chilled beam system and if the design of the building has changed because of their use.
6. Interview Pierce Associates to determine how they have familiarized themselves with the system in order to properly install it.
7. Research the typical costs of an HVAC system that would be installed into a building similar to Constitution Center and compare the costs.

#### **Survey Questions**

1. Does your company utilize commissioning?
2. Does your company have full time staff that completes commissioning?
3. Does your company use a specific program for commissioning?
  - a. If so, what program(s)?
4. What is one suggestion to make commissioning easier?

## **Expected Outcome**

The expected outcome of this research is to become familiar with the chilled beam system. Also, the goal is to understand why the system was chosen to be utilized at Constitution Center. Finally, the impacts that the system will cause on the cost, schedule, and site logistics will be outlined. From this information, it will be compared to typical systems being installed in similar building to see if the costs outweigh the benefits.

## ***Analysis 2: Curtain Wall Installation Procedures***

### **Problem/Opportunity Statement**

The curtain wall of Constitution Center is another construction management issue that will provide an area for research. The installation of the façade played a major role in how the exterior site work was phased and researching the installation will allow the productivity to be tracked.

### **MAE Graduate-Level Component**

With this research, *CE 533 – Construction Productivity Analysis and Performance Evaluation* graduate class will be incorporated into the thesis research. Within this class, productivity measurements, control, and forecasting were addressed, along with the factors affecting productivity and the methods for improving the productivity. All of these elements play an important role in the installation of the curtain wall.

### **Potential Solution(s)**

A potential solution to the installation of the curtain wall is to use a prefabrication system instead of installing each piece separately. This may have potential schedule and cost savings impacts that affect the overall construction of Constitution Center.

### **Research Steps**

1. Research the panel descriptions (dimensions, weight, etc.) and become familiar with the installation requirements.
2. Determine how the panels were shipped and how often.
3. Determine where the panels were stored and if there were any restrictions.
4. Determine if preparation was needed before the panels were installed.
5. Determine what type of equipment was needed to install the panels.
6. Interview the DAVIS project team to see if they kept a record of how many people worked on the installation each day and how many pieces were installed on that particular day
7. Determine if weather was a factor in the installation process.
8. Determine the Rules of Credit using R.S. Means
9. Using CE 533 information, calculate:
  - a. Expected and Actual Productivity
  - b. Expected Performance Factor
  - c. Planned and Actual Manning
  - d. Actual Percent Complete
  - e. Control Budget

10. If any delays occurred, determine the factors for the delays.
11. Compare this data to the data collected from the CE 533 semester project of the Dickinson School of Law to determine if the installation procedure is productive.

**Data Collection Tool**

A table, similar to Table 1, will be used in order to gather the appropriate information to determine the productivity of the curtain wall installation. As one can see, the table is neatly laid out in order to incorporate all of the activities needed for the installation, the amount that were actually installed, and the weather for that day. The table would be updated to match the activities for Constitution Center’s curtain wall installation. The weather will be tracked using achieved information from the National Weather Service.

Monday, March 17, 2008						
Activities						
Info:	Set Glass	Diverters	Pressure Bar	Caulking/Snap Covers	Total	Man hours
Rules of Credit	.4	.15	.15	.3	1	Hours
Quantity Installed (panels):	18	18	9	0	11	60
*Weather:	High	Low	Average	Perc. (in.)	Weather Comment	
	46	25	35.5	0.00	Sun and some clouds	

*Table 1: Example of form used to collect data from CE 533.*

**Expected Outcome**

The expected outcome of this research is to familiarize myself with the curtain wall installation procedures. After that I will be able to apply my knowledge learned in CE 533 to determine the productivity of the installation. If it does not meet a satisfactory productivity I will determine other productive ways to install the curtain wall.

**Note:**

Although an analysis of the actual curtain wall panels are not permitted due to security reasons, a study of the façade from a constructability perspective will take place and will not be affected by the security requirements.

### *Analysis 3: Structural Integrity of the Parking Garage Waffle Slabs*

#### **Problem/Opportunity Statement**

The structural integrity of the parking garage waffle slabs was a construction management topic that incorporates a structural breadth. There were areas of the parking garage that had to be supported, the selection tore out, and a new area poured. Because of these areas, quadrants of the three level parking garage were closed for months at a time. These closures provided less construction parking and less onsite storage.

#### **Structural Breadth**

Analysis of the structural system will be conducted in order to determine the renovation requirements of the waffle slab. If necessary, an updated or new system will be proposed. There are two options for a redesign: a two-way reinforced concrete system or a flat plate, drop panel with column capitals. Both of these redesigns will have to have a detailed analysis on loads, cost, and schedule and will provide a structural breadth to be applied to the construction management issue.

#### **Potential Solution(s)**

A potential solution is to determine if there are other ways to renovate the slab without hindering the use of the quadrant for both construction parking and material storage.

#### **Research Steps**

1. Determine the structural requirements of the parking garage waffle slabs.
2. Determine the loads that the slabs are experiencing.
3. Research how the waffle slabs were renovated.
4. Determine what qualified a section to be renovated.
5. Interview DAVIS project team in order to determine the schedule requirements of the renovation of the waffle slabs.
6. Interview the subcontractor in order to determine the steps necessary for the renovation.
7. Research other means of fixing the waffle slabs.
8. Determine if there are schedule acceleration options available and used on other sites.

#### **Expected Outcome**

By conducting this research, the outcome that I expect to find is if there are other ways to renovate the waffle slab, without taking away the structural integrity.

## *Analysis 4: Critical Issue Research Method - Pedestrian Safety*

### **Problem/Opportunity Statement**

The critical industry issue, which also is a construction management issue, was the requirements for safety on jobsites. Since the L'Enfant Metro Station Entrance was within the construction site, it was a problematic feature to keep the pedestrians safe, but not limiting the use of the metro or the work taking place on the construction site. Safety is one of the biggest factors on jobsites, I would like to increase my knowledge on how companies are initiating the efforts to make their sites safer. The general audience and benefactor of this research are the companies that are managing jobsites.

### **Research Steps**

1. Determine what safety requirements are utilized on the entire Constitution Center site.
2. Determine the OSHA requirements for areas within a construction site that are also open to the public.
3. Interview the DAVIS project team in order to determine if there were any special safety techniques that were unique to the site.
4. Create a survey to be sent to industry members to determine their site safety requirements.
5. Compile the results into a useful format in order to determine how companies are implementing safety procedures on their sites.

### **Survey Questions**

5. Does your company have a safety department?
6. Does your company have a full time safety manager on your site?
7. Does your company require specific safety training?
  - a. If so, what type?
8. What types of consequences are enforced on your sites for not following safety procedures?
9. Do your sites have a full time nursing staff?
10. Does your company require a drug test before starting work on your sites?

### **Expected Outcome**

The expected outcome of this research is to determine what safety requirements are implemented on job sites today and to determine if there were other ways to protect the pedestrians using the L'Enfant Metro Station.

## WEIGHT MATRIX

The weight matrix below illustrates how I plan to distribute my efforts among the different analyses. Within these four analyses critical issue research, value engineering analysis, constructability review, and schedule reduction/acceleration will be addressed.

Description	Research	Value Engineering	Constructability Review	Schedule	Total
Chilled Beam System (Mechanical Breadth)	30%	5%	0%	0%	<b>35%</b>
Curtain Wall	0%	5%	15%	5%	<b>35%</b>
Structural Integrity of the Parking Garage Waffle Slabs (Structural Breadth)	5%	5%	5%	10%	<b>25%</b>
Pedestrian Safety (Critical Issue Research)	10%	0%	5%	0%	<b>15%</b>
<b>Total</b>	<b>45%</b>	<b>15%</b>	<b>25%</b>	<b>15%</b>	<b>100%</b>

*Table 2: Weight Matrix showing the level of emphasis on each analysis.*

## TIMETABLE

### *January*

- Visit the Constitution Center jobsite
- 7<sup>th</sup> – TROX USA Inc. site visit
- 8<sup>th</sup> – Recap of experience at TROX USA Inc.
- Analysis 1 completed

### *February*

- Analysis 2 – 4 started
- Send out safety surveys
- Analysis 3 completed

### *March*

- Evaluate safety surveys
- Analysis 2 and 4 completed

### *April*

- Begin final presentation
- 13<sup>th</sup> – Faculty Jury

## APPENDIX A:

### *Mechanical Breadth*

While analyzing the chilled beam system, the chance to evaluate the commissioning requirements for the mechanical systems will provide an opportunity for a mechanical breadth as well as a critical industry issue. With a project the size of Constitution Center, the commissioning requirements are very detailed. After evaluating the requirements, if necessary an updated or new system of tracking the commissioning will be proposed.

### *Structural Breadth*

Analysis of the structural system will be conducted in order to determine the renovation requirements of the waffle slab. If necessary, an updated or new system will be proposed. There are two options for a redesign: a two-way reinforced concrete system or a flat plate, drop panel with column capitals. Both of these redesigns will have to have a detailed analysis on loads, cost, and schedule and will provide a structural breadth to be applied to the construction management issue.