

1000 CONTINENTAL SQUARE

Carter Hayes
Structural Option 2008



OUTLINE

- ▣ Introduction
 - Building Overview
 - Building Site
 - Existing Design
 - Thesis Purpose
- ▣ Depth Study – Concrete Redesign
 - Redesign Overview
 - Floor Diaphragm
 - Columns and Foundations
 - Lateral Systems
- ▣ Breadth Study One – Architectural
 - Use Requirements
 - Layout Aspects and Plans
- ▣ Breadth Study Two – Lighting
 - Daylighting Analysis
 - Final Design
- ▣ Conclusions and Questions



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Building Overview

- Location: King of Prussia, PA
- Use: High-End Commercial Offices
- Status: Currently under Construction
- Price: \$40 Million
- Area: Approx. 200,000 sq. ft.
- Size: 6 Stories, 78' at Main Roof
- Owner: BPG Properties, Ltd.
- Architect: SPG3 Architects

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Building Site



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Building Site



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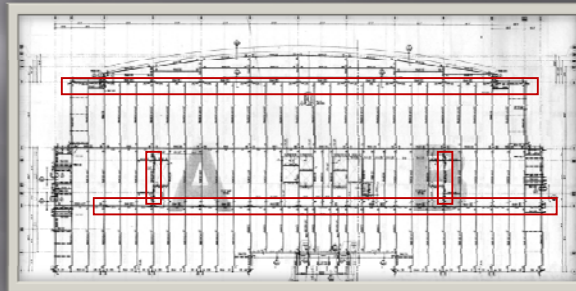
Existing Design

- Composite Steel Structural Frame
 - 3" 20 Gage Composite Deck
 - 6 1/4" Lightweight Slab
 - 5" Long 3/4" Diameter Headed Studs
- Two Different Lateral Systems
 - Two moment frames in the long direction
 - Two eccentrically braced frames in the short direction
- Spread footings throughout the building
- Additional strip footings under the ground floor retaining wall

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Existing Design



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Thesis Purpose

- To redesign current steel structural system in concrete.
- To reduce cost, time, and inefficiency in the overall design.
- To create a more functional, serviceable final product.



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DEPTH STUDY

Structural Redesign in Concrete



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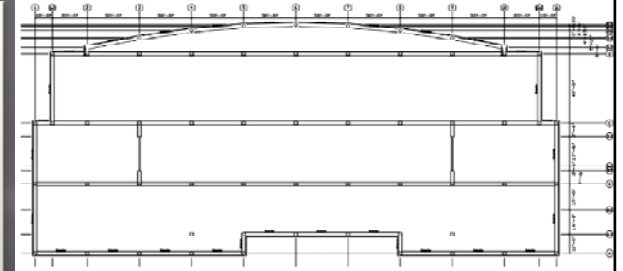
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Redesign Overview

- Pan-Joist Slab
 - 24.5" overall slab thickness
 - 30" forms
 - 6" ribs
- Beams
 - 24" x 24.5"
- Columns
 - 18" x 24"
- Spread Footings



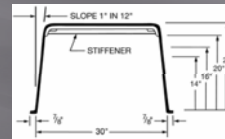
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Floor Diaphragm

“...efficient for projects with heavy superimposed loads and provide a two hour fire rating...”

20"	6"	.605	.730
	7"	.640	.765
	8"	.674	.799



From CECO Concrete Construction

20"	3.933	2.541	1.850	1.155	1.043	N.A.
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Structural Option

FLANGEforms

FLANGEforms are available in steel, steel-in-wood and wood. These forms are among the most popular because of their flexibility in access, mobility, erection, removal and joint details when required. They are available in a variety of widths, heights and configurations. They have a quick erection and dismantling process. They are also efficient for projects where the structure is not required to support a load. They are also used for projects where the structure is required to support a load. They are also used for projects where the structure is required to support a load.

The varying depths provide flexibility to meet a wide range of spans and loads. Further, they all accommodate steel reinforcement and communication distribution systems. CECO FLANGEforms are capable of producing round structural members, but are incapable of producing light tubulars and round beams. The form is a snap-on design and the finished wall has a regular width, a rough finish, and offset at both the top and bottom.

If a higher quality finish is required, FLANGEforms with the optional Cast-In-Place Formwork (CIP) system are available. The additional cost of higher quality forms is offset by having only one form. Contact your CECO representative for assistance.

Concrete Quantities/20' Width	
Span (ft)	Concrete (cu yd)
10	1.000
12	1.200
14	1.400
16	1.600
18	1.800
20	2.000
22	2.200
24	2.400
26	2.600
28	2.800
30	3.000

Concrete Quantities/20' Width	
Span (ft)	Concrete (cu yd)
10	1.000
12	1.200
14	1.400
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18	1.800
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22	2.200
24	2.400
26	2.600
28	2.800
30	3.000

Forms Created by Various Size PLANS Formwork

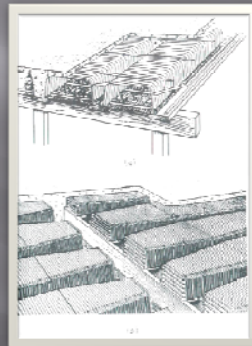
Span (ft)	Concrete (cu yd)	Formwork (sq ft)
10	1.000	100
12	1.200	144
14	1.400	196
16	1.600	256
18	1.800	324
20	2.000	400
22	2.200	484
24	2.400	576
26	2.600	676
28	2.800	784
30	3.000	900

Dimensions

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Floor Diaphragm



- Pan-Joist Assembly
- Spans 40' Direction
- 100 psf Live Load
- Two Hour Fire Rating
- Final Design
 - 30" Forms
 - 6" x 20" Ribs
 - 4.5" Topping Slab
 - 24.5" Overall Depth

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7030 Continental Square

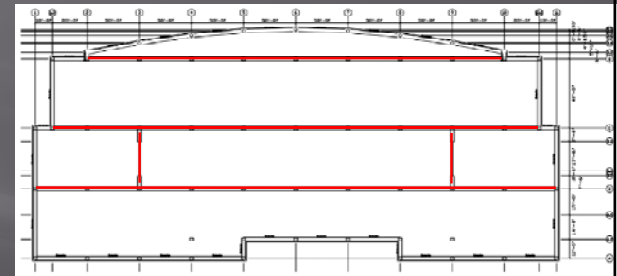
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Floor Diaphragm

- Beam Design
 - Typical Interior Beam
 - 24" x 24.5"
 - Reinforcement:
 - Top: (4) #11's
 - Bottom: (2) #10's
 - Stirrups: (13) #3's; 1@2", 12@10"
 - Typical Exterior Beam
 - 24" x 24.5"
 - Reinforcement:
 - Top: (4) #9's
 - Bottom: (2) #10's
 - Stirrups: (13) #3's; 1@2", 12@10"

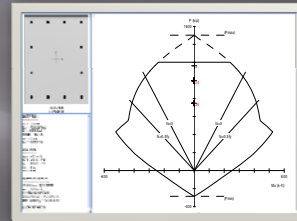


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Columns and Foundations

- Column Design
 - 18" x 24"
 - (12) #6's, 4x2
 - Designed in RAM
 - Checked with PCA Column
- Foundation Design
 - Typical Interior Foundation:
12'x 12', (13) #7's in each direction
 - Typical Circular Column: 9'x 9', (11) #6's in each direction



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Lateral Systems

- Similar to the system in the original design
 - Three moment frames in the long axis direction (E-W)
 - Two shear walls in the short direction (N-S)
- Shear Wall Design
 - Moments from RAM were used in PCA Wall
 - 10" wide x 20' long:
 - #5 @ 10" horizontally, #5 @ 16" Vertically, (8) #9's in B.E.
- Design Checks
 - Drift, Story Drift, Overturning Moment, and Torsion

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Lateral Systems

- Extreme torsion at first floor

RELATIVE STIFFNESS					
Floor	N-S		E-W		
	SW 1	SW 2	MF 1	MF 2	MF 3
1	50.0 %	50.0 %	33.5%	52.2%	14.3%
2	50.0 %	50.0 %	26.6%	37.8%	35.6%
3	50.0 %	50.0 %	29.7%	35.9%	34.4%
4	50.0 %	50.0 %	29.8%	35.9%	34.3%
5	50.0 %	50.0 %	29.8%	35.9%	34.3%
Roof	50.0 %	50.0 %	29.8%	34.2%	36.0%

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DESIGN SHEAR IN EAST -WEST DIRECTION				
Floor	Direct Shear	Total MF1	Total MF2	Total MF3
1	5.18	2.23	21.63	1.06
2	8.68	2.63	8.43	3.53
3	28.22	9.53	19.66	11.10
4	34.36	11.64	20.57	13.57
5	141.76	48.01	79.23	56.03
Roof	179.60	60.23	91.00	73.46

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BREADTH STUDY ONE

Architectural Investigation of
Interior Spaces



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Use Requirements

- Mid-Large sized AE Firm: ~70 Employees
- Ample desk space: > 40 sq. ft./desk
- Additional Conference Room Space

Use	Percent Area at TT	Resulting Area	Percent Area at 1000	Actual Area of Design	Percent Difference
Cubicles	44.76%	6644	45.50%	6382	-3.94%
Offices	22.40%	3325	13.17%	1847	-44.45%
Conference rooms	13.69%	2032	19.74%	2769	36.29%
Kitchens	4.43%	657	4.56%	640	-2.56%
Libraries	7.24%	1074	9.04%	1268	18.04%
Drafting areas	4.90%	727	5.49%	770	5.94%
Waiting areas	2.59%	384	2.49%	349	-9.08%

Values taken from available space in Thornton Tomasetti's New York City Office

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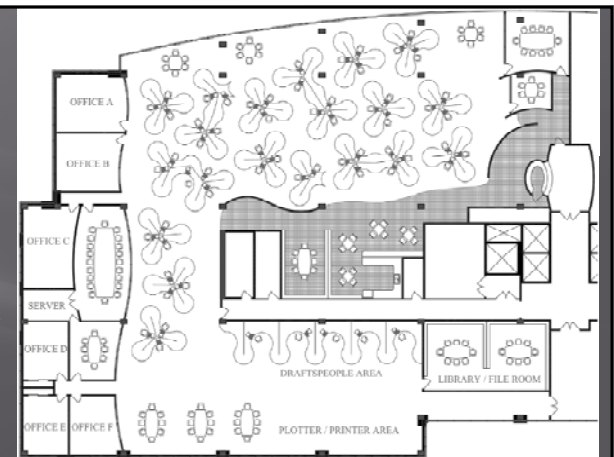
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Layout and Plans

- Curvilinear partitions echo the north façade.
- Concentric elliptical reception area mirrors that of the building's main entry.
- Extensive use of glass preserves the open floor plan.
- Freeform desks and arrangement continue meandering floor plan.
- Simple open design and modular furniture allows for adaptability.

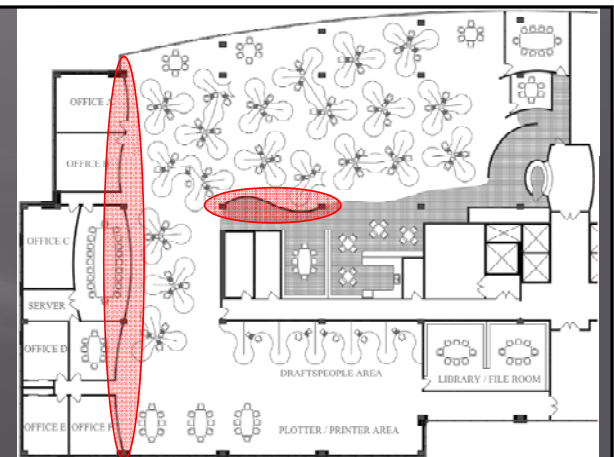


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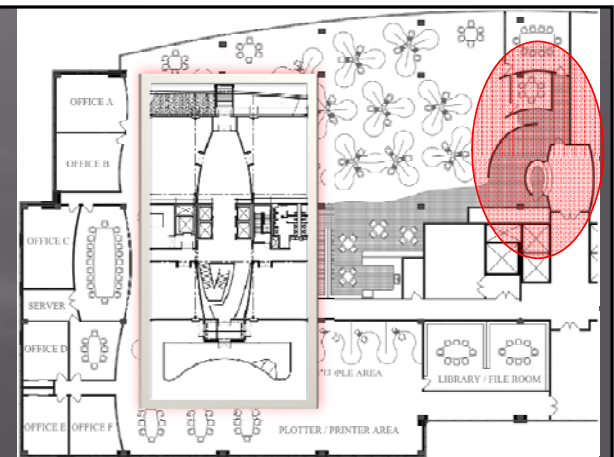


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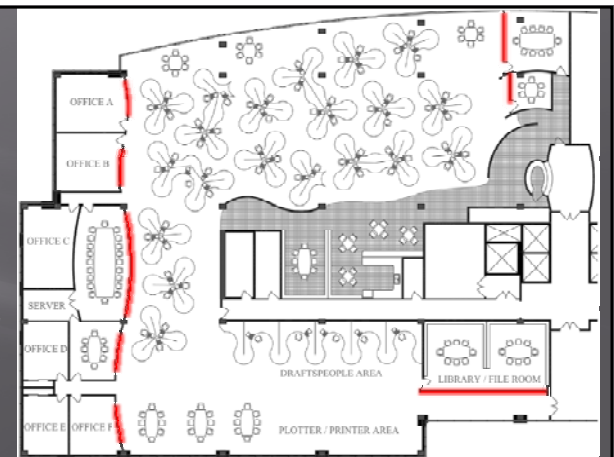


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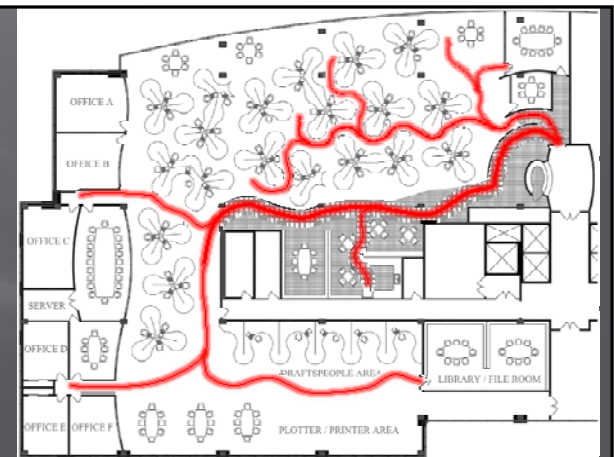


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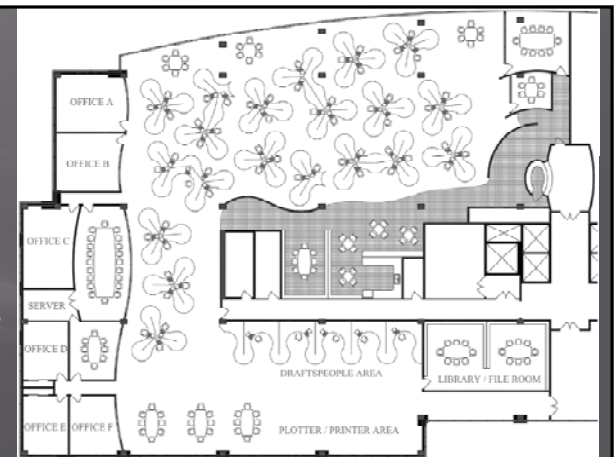


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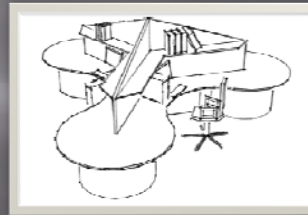


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The Uncubicle

- Healthier Ergonomics
- Greater Adaptability
- Superior Aesthetic
- Increased Efficiency



- An innovative, modular design alternative to mundane, common cubicles.

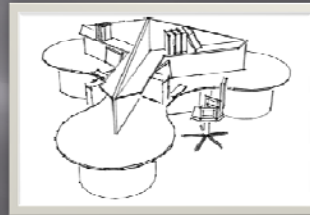


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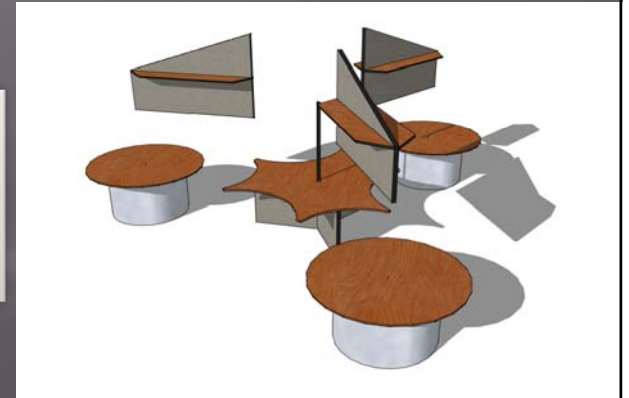
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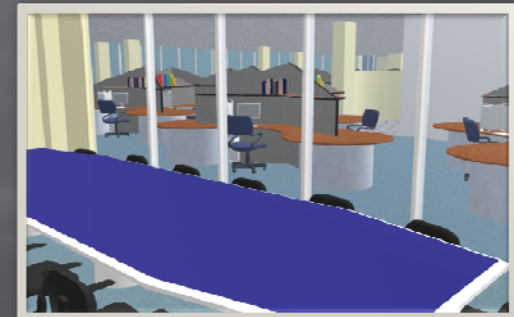
Interior Spaces



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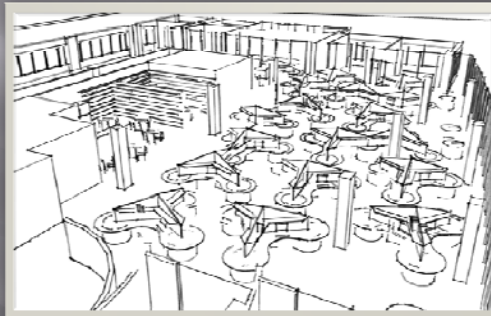
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BREADTH STUDY TWO

Development of Interior Lighting Design



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Daylighting Calculations

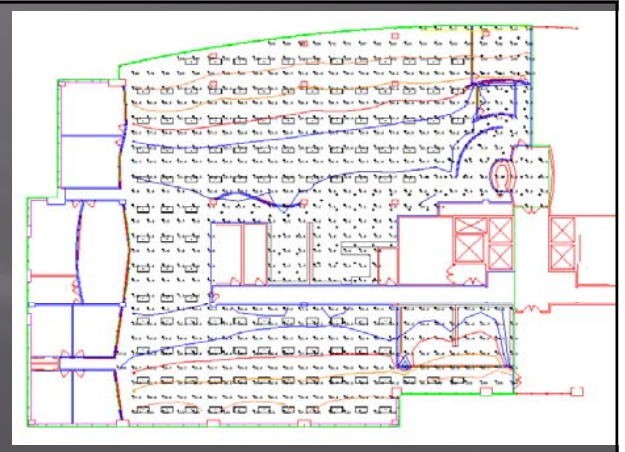
- Step One: Chose adequate light fixtures
 - Smaller recessed downlight for narrow or curved spaces
 - 2' x 4' recessed troffer for general lighting
- Step Two: Calculate Maximum Spacing
 - Use spacing criteria and distance to work plane to create preliminary layout
- Step Three: Model Floor Plan in AGi32
 - Space was modeled in 3D AutoCAD, the luminaries inserted in AGi32
- Step Four: Effects of daylighting were analyzed
 - Illuminance was compared to the minimum level for office space

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Final Design

- The depth light penetrates the building varies depending on the weather conditions and date
 - **Summer Solstice: ~25' on the northern side (3 Rows)**
 - Winter Solstice: ~20' on the northern side (2 Rows)
 - Overcast Day: ~10' on the northern side (1 Row)
- If the first three rows of light were all on distinct separate circuits they could be varied as conditions changed as shown above.
- A sensor and dimmer could automatically maximize system efficiency.

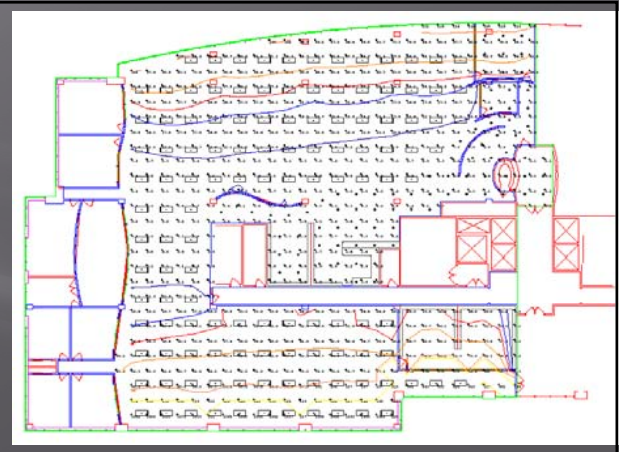


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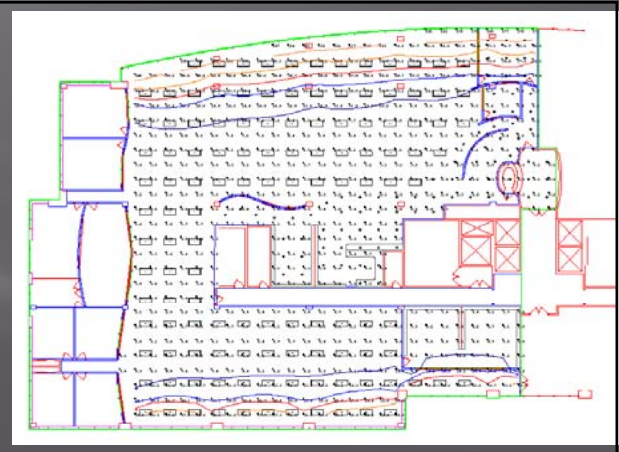


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Renderings



Carter Hayes

1000 Continental Square

Structural Option



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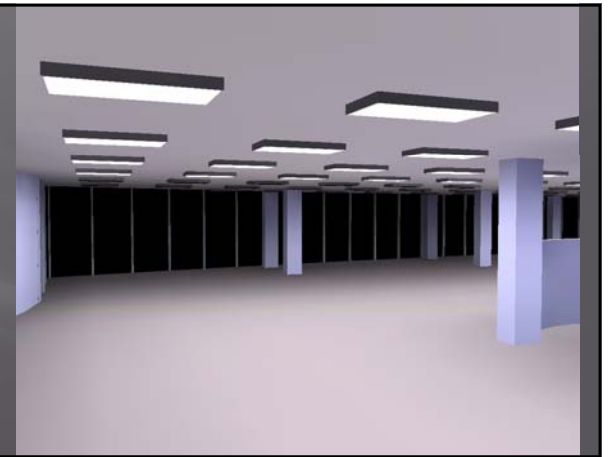
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Conclusions

- Structural
 - The final concrete design proposed in this thesis failed to be more efficient than the existing steel design.
 - The final design cost is approximately \$2.50 more per square foot and although lead time was shortened, overall completion could be up to two months longer.
 - Concrete could be feasible if the project demanded stricter height limitations, more stringent vibration regulations, tighter site conditions, or more plenum space for MEP systems.

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Conclusions

- Architectural
 - The office layout is a feasible model for an AE Firm and would provide an adaptable and hopefully stimulating workplace through its variety of architectural aspects.
- Lighting
 - If the proposed zone system were implemented it would have the ability to save building tenants 13,500 kWh in just the two main areas.
 - This equates to over \$2000 dollars at today's energy prices in Philadelphia.

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