

Naval Network & Space Operations Command (NNSOC)

Dahlgren, VA

Christopher Ankeny
Lighting/Electrical Option
Senior Thesis 2007

Advisor: Dr. Richard Mistrick
Electrical Consultant: Mr. Ted Dannerth

Background

Building Overview

Location: Naval Surface Warfare Center Dahlgren Division, Dahlgren, VA

Size: 75,000 s.f., 2 Stories

Cost: \$17,000,000

Occupant: Navy

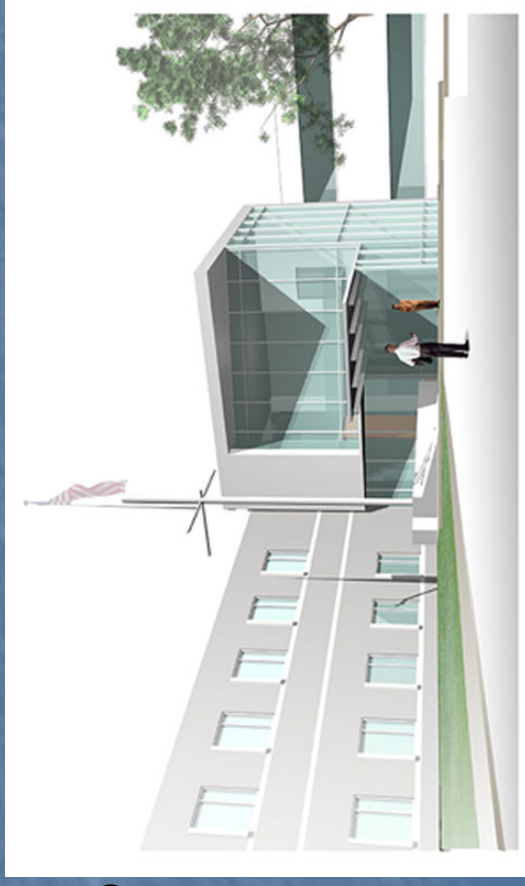
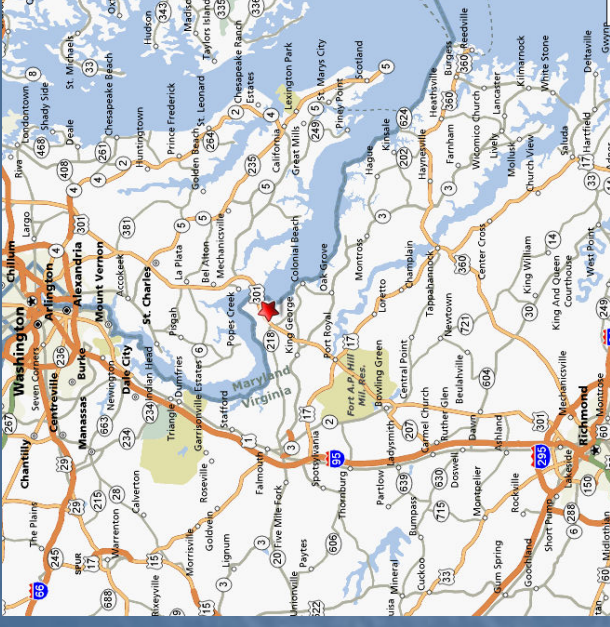
Function: Mixed Use, Office, with some assembly (training theater)

Architecture and Engineering: Kling, D.C.

Construction Management: Skanska Corp., MD

Deliverable: Design-Build

Architecture: "The primary mission of the NNSOC is to provide a secure, flexible, high quality work environment for researchers and administrative personnel in a building that is an efficient, economical asset for the base."



Picture and drawings courtesy of Kling in Washington D.C.

NNSOC

Outline

Lighting Depth

- Outdoor/Entrance
- Open Office
- Lobby*
- Training theater*

Electrical Depth





- Uninterruptible Power System (UPS)
- Photovoltaic Analysis*

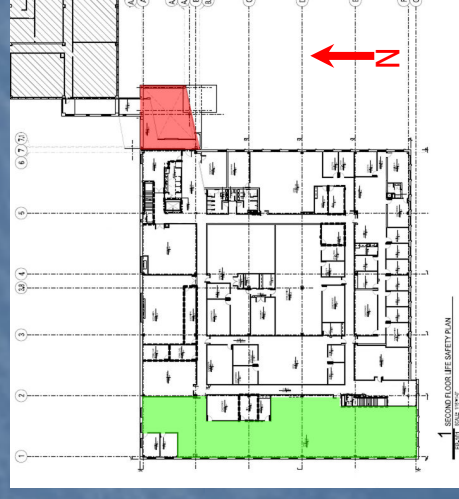
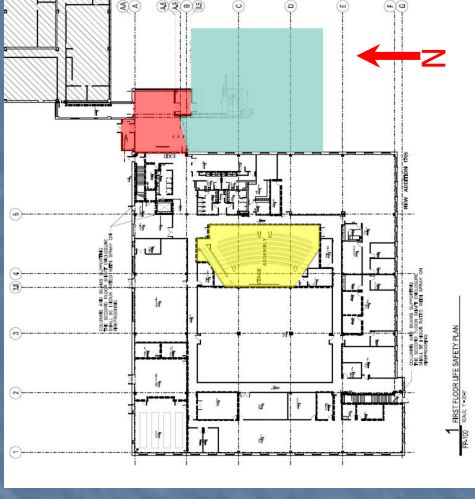
Mechanical Breadth

Construction Management Breadth*

Conclusions

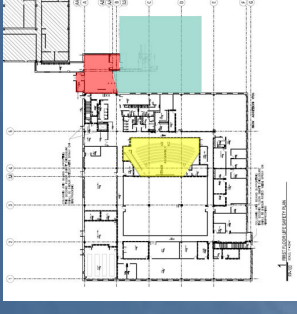
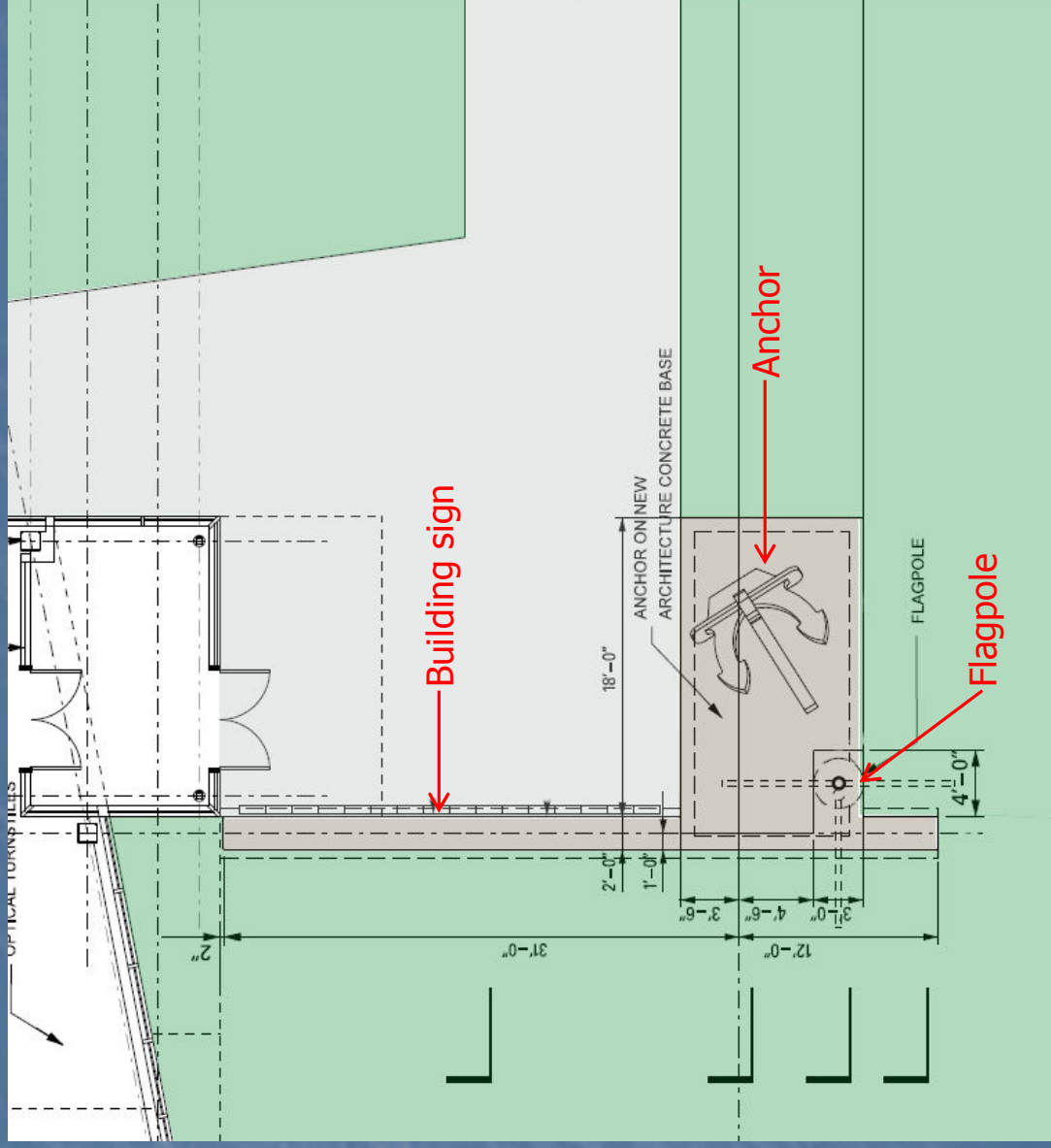
*Topics not covered in presentation

- Outdoor/Entrance: 
- Lobby: 
- Training Theater: 
- Office: 



Lighting Depth: Outdoor/Entrance

Introduction



Design Concept

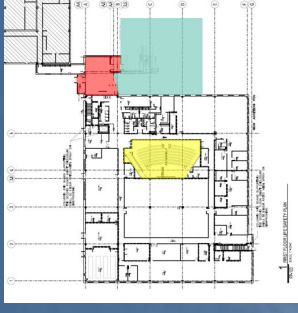
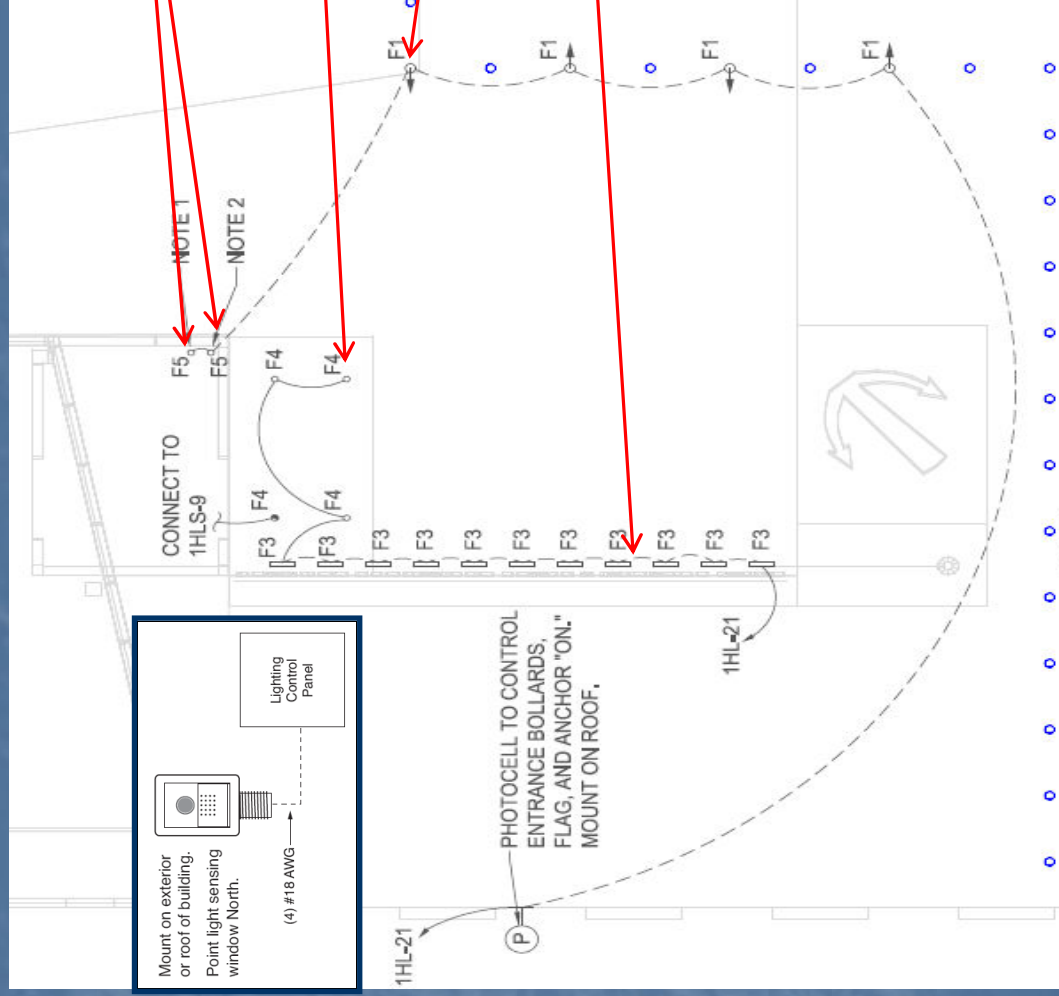
- Highlight the anchor, flag, and building sign
- Provide design that acknowledges our Navy and Nation

Design Goals

- Provide enough light for egress
- Have good contrast between highlighted areas and background

Lighting Depth: Outdoor/Entrance

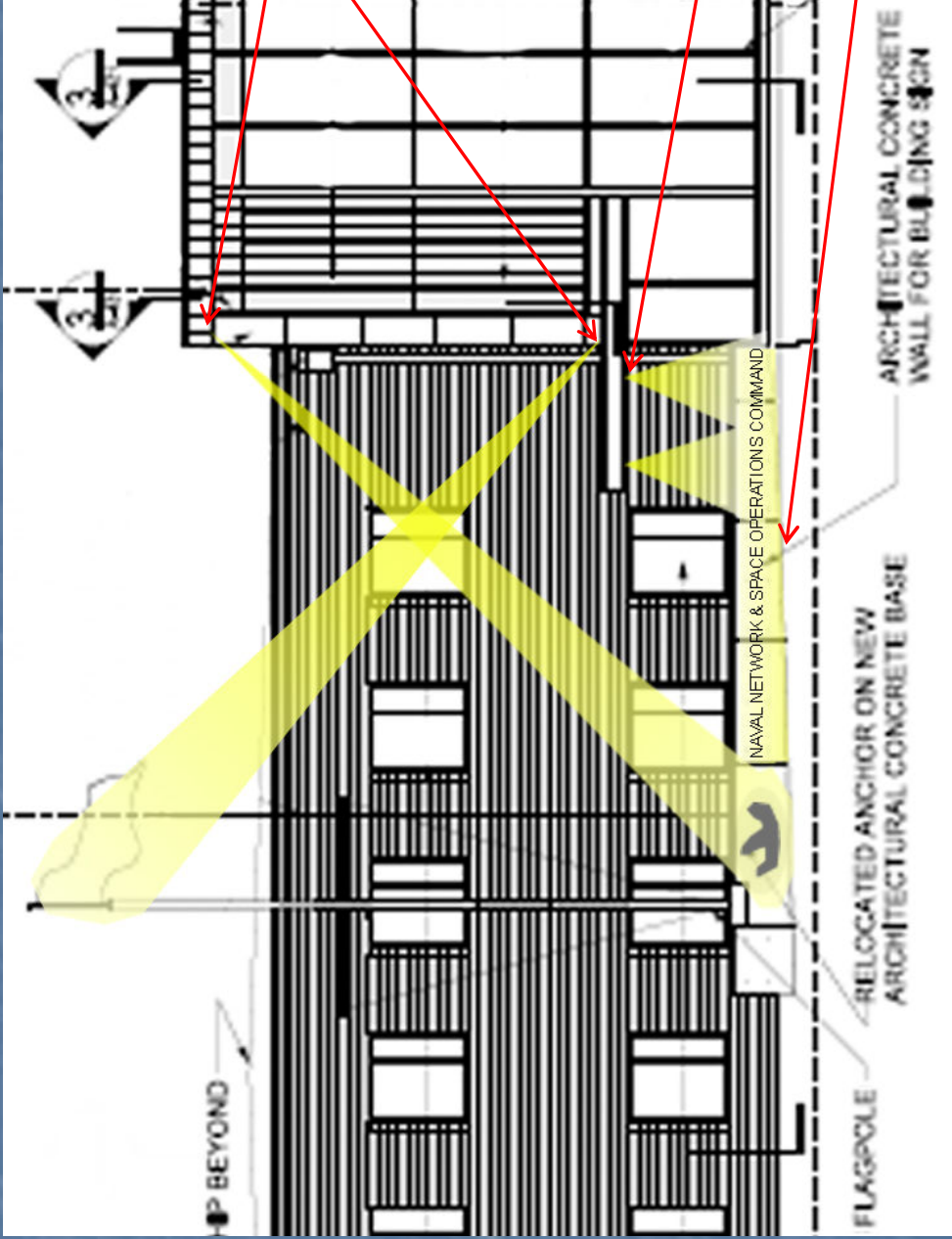
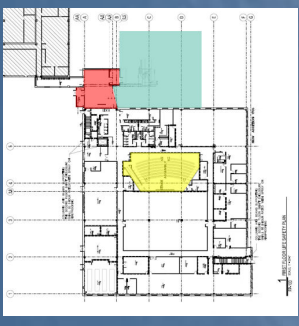
Layout



Type	Description	Lamping	CCT
F1	EXTRUDED ALUMINUM BOLLARD LUMINAIRE WITH TYPE V, 360 DEGREE LATERAL LIGHT DISTRIBUTION. NOMINAL 42" HIGH x 8.5" DIAMETER. FINISH IS TO MATCH SECURITY BOLLARDS.	(1) CMH70/TD/942RX7S	4200
F3	RECESSED PROJECTOR, TYPE VI, FIXED REFLECTOR LUMINAIRE. NOMINAL 19" x 3.6". DRIVE OVER RATED, WATERPROOF.	(1) FM 11W/760 W4.3 UNV1	6000
F4	CAST ALUMINUM, SILVER POWDER-COATED TYPE V DOWNLIGHT, NOMINAL 8" DIAMETER x 9" DEPTH. CUT-OFF ANGLE 30 DEGREES. WATER-JET PROOF.	(1) F-18TBX/SPX41/A/4	4100
F5	CORROSION-RESISTANT CAST ALUMINUM TYPE V BEAMER II PROJECTOR, NOMINAL 12" HIGH x 6.25" DIAMETER. 130 DEGREE TILT. MOUNTING PLATE FOR METAL HALIDE LAMPS. CUT-OFF ANGLE 60 DEGREES. WATER-JET PROOF.	(1) CMH357T/UVJ/830/G1 2	3000

Lighting Depth: Outdoor/Entrance

Elevation



Lighting Depth: Outdoor/Entrance

Renderings



NNSOC

Lighting Depth: Outdoor/Entrance

Renderings



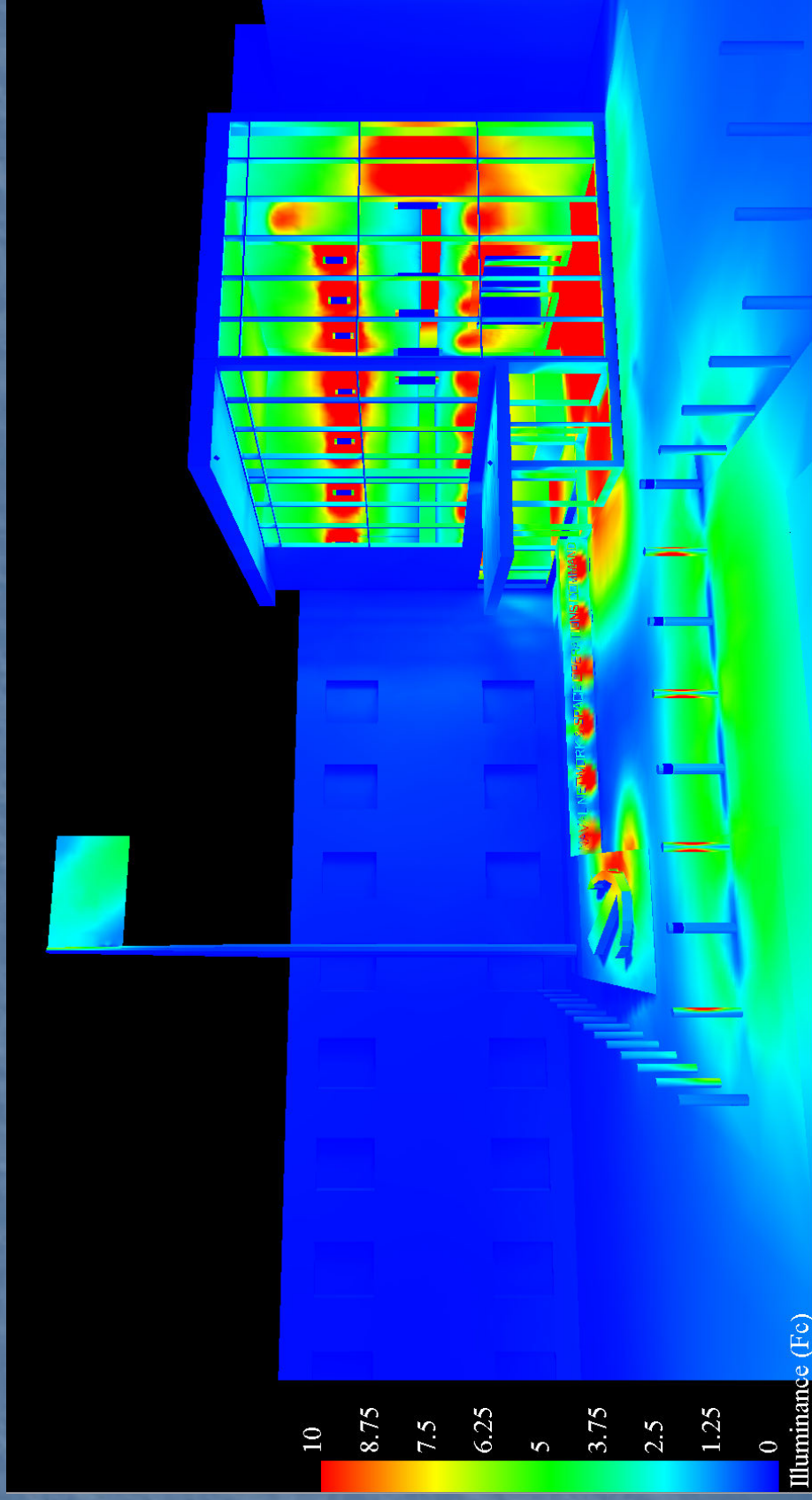
Summary

- Highlighted the flag, anchor and sign
- Provided transition into lobby area
- Power Density in (W/s.f.) is:
 - 0.17 for walkway (ASHRAE 90.1 < 0.20) **OK**
 - 0.56 for Entrance (ASHRAE 90.1 < 1.25) **OK**

NNSOC

Lighting Depth: Outdoor/Entrance

Performance



Outline

Lighting Depth

- Outdoor/Entrance
- Open Office**
- Lobby*
- Training theater*

Electrical Depth





- Uninterruptible Power System (UPS)
- Photovoltaic Analysis*

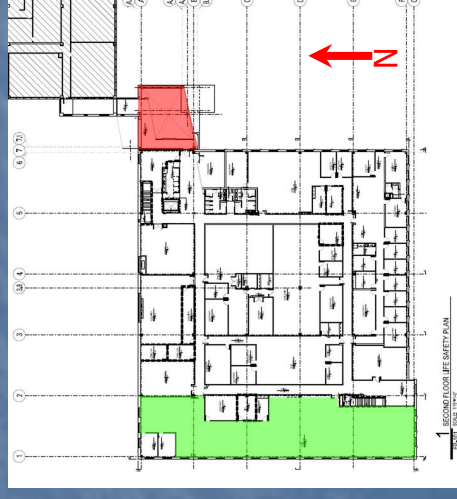
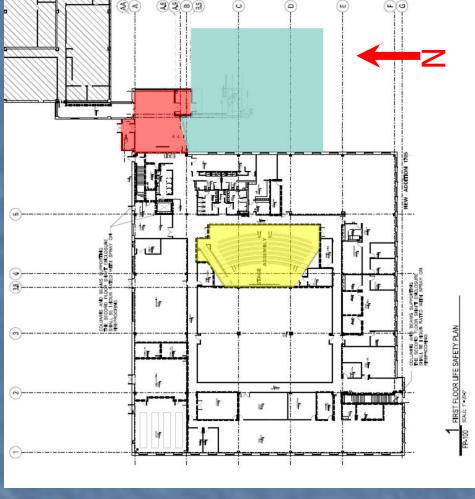
Mechanical Breadth

Construction Management Breadth*

Conclusions

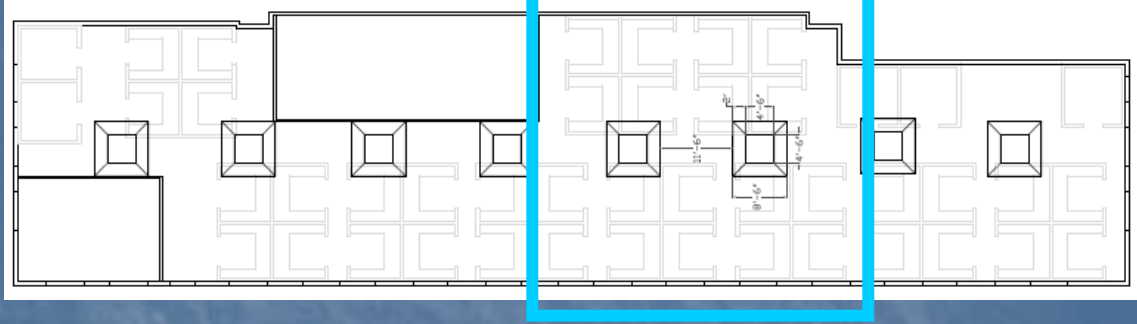
*Topics not covered in presentation

- Outdoor/Entrance: 
- Lobby: 
- Training Theater: 
- Office: 

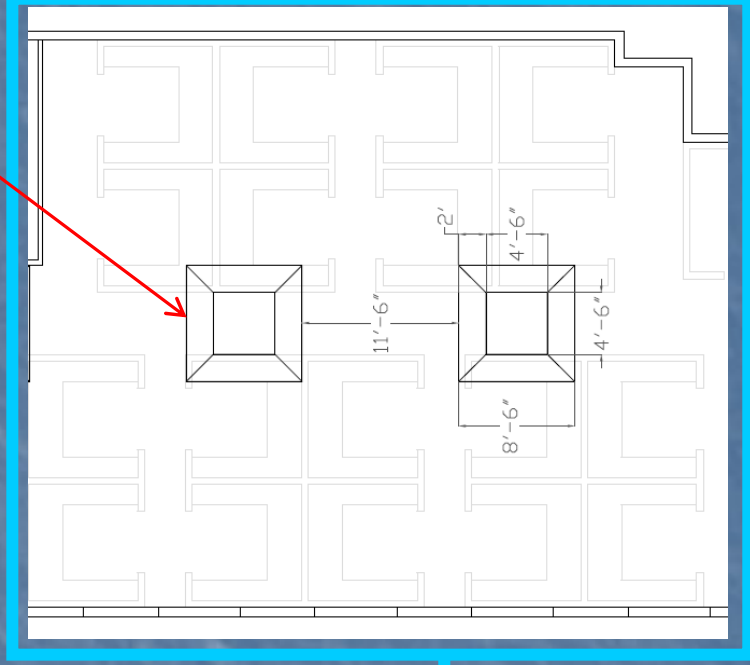


Lighting Depth: Open Office

Introduction



Skylight Detail



Design Concept

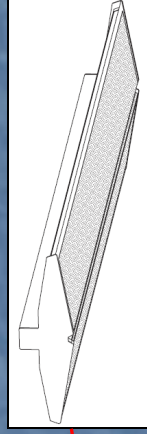
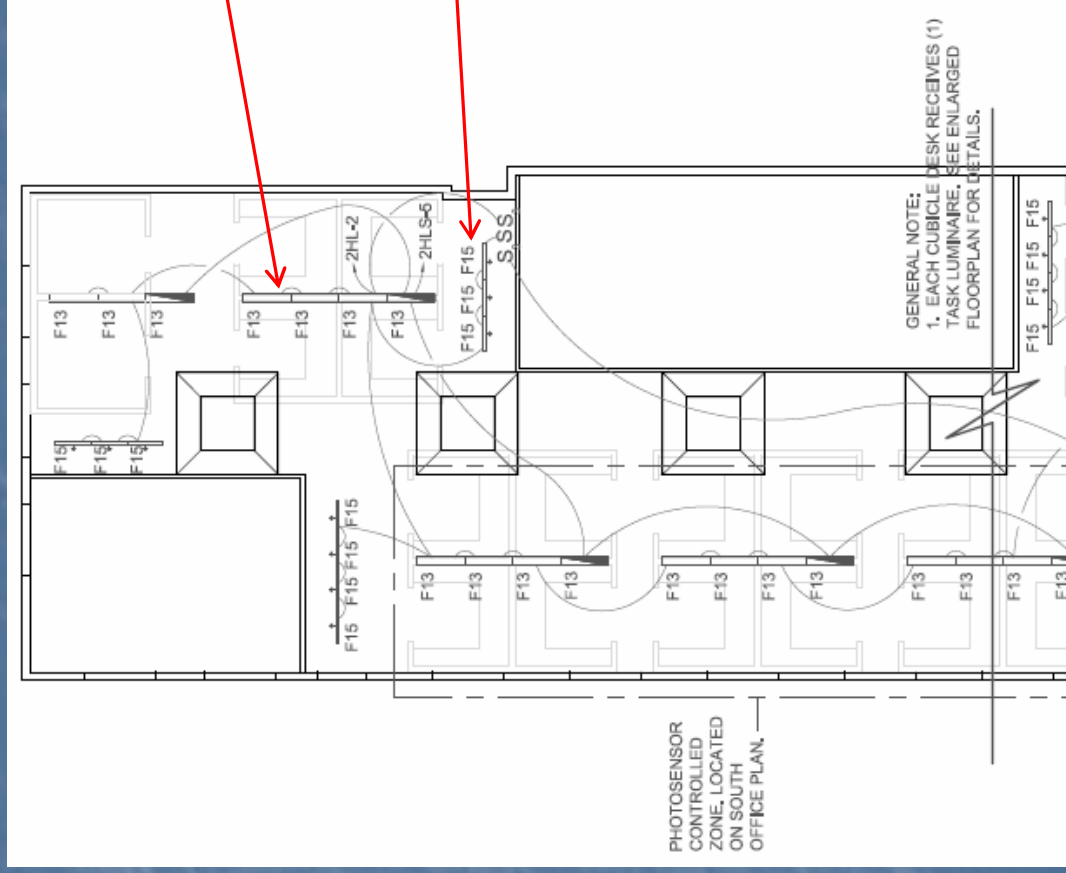
- Add in skylights for better daylight integration
- Provide ambient and task lighting
- Use a photosensor to control dimmable ambient fixtures
- Have manual shades on west and south windows to limit direct sunlight penetration

Design Goals

- Provide about 30 fc of light from the ambient system and 50 fc from the task lighting
- Use 4100K CCT to try and match daylight

Lighting Depth: Open Office

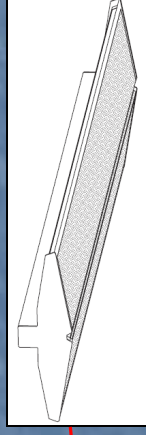
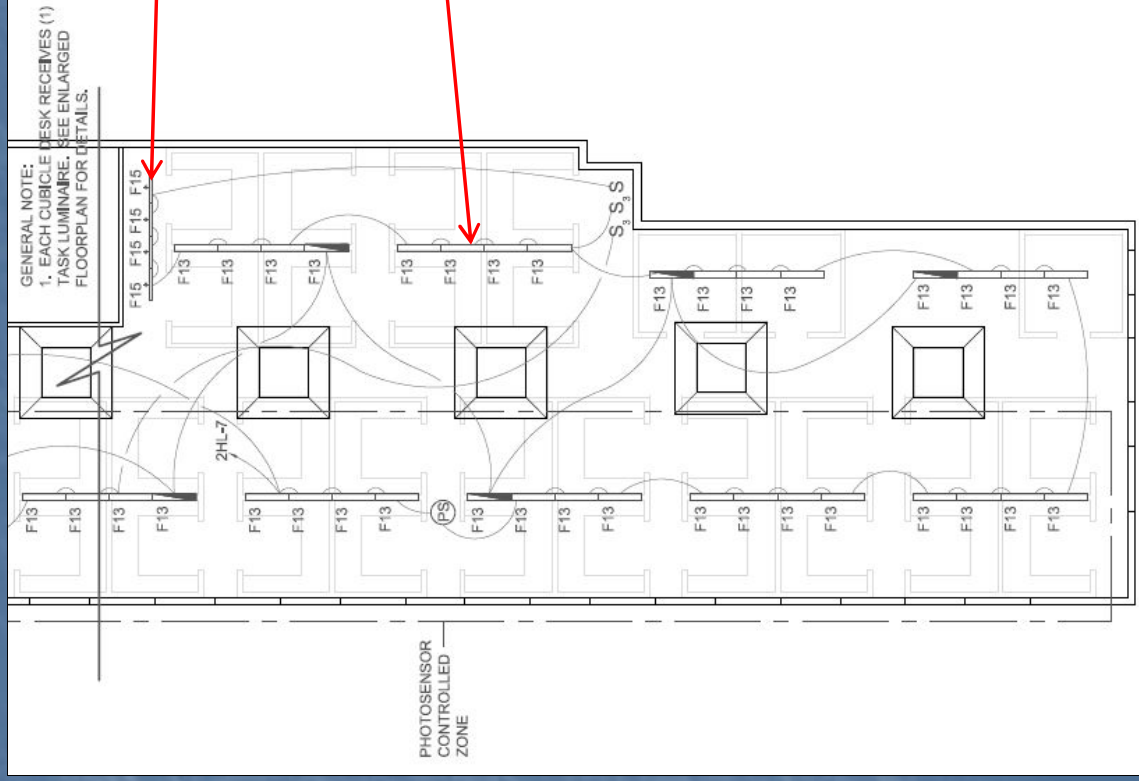
North Layout



LUMINAIRE SCHEDULE			
Type	Description	Lamping	CCT
F13	INDIRECT SUSPENDED LINEAR FLUORESCENT, DOUBLE DIFFUSER OPTICAL DESIGN, 96% REFLECTIVE WHITE PAINT. NOMINAL 3.5"x12"x48". CAN BE CONNECTED IN SECTIONS. TYPE 6 SYMMETRICAL DISTRIBUTION.	(1) F54W/T5841/ECO	4100
F14	WORKSTATION LUMINAIRE FOR INSTALLATION ON OPEN OFFICE FURNITURE PANELS. DESIGNED TO PROVIDE LOW-GLARE TASK LIGHTING FOR HORIZONTAL SURFACES. NOMINAL 6"x2.5"x36". TYPE IV ASYMMETRICAL DISTRIBUTION. PLUG IN CONNECTION TO RECEPTACLE OUTLET.	(1) F21W/T5841/ECO	4100
F15	SURFACE MOUNTED WALLWASH, ASYMMETRICAL DISTRIBUTION, TYPE IV FIXTURE. NOMINAL 5"x2.5"x36". MATTE WHITE FINISH WITH DECORATIVE ENDPLATES. CAN BE CONNECTED IN SECTIONS.	(1) F21W/T5841/ECO	4100

Lighting Depth: Open Office

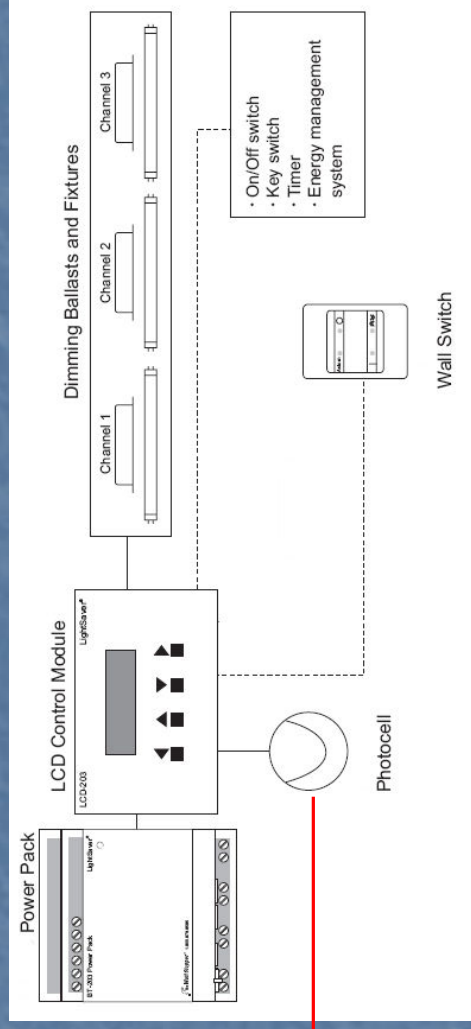
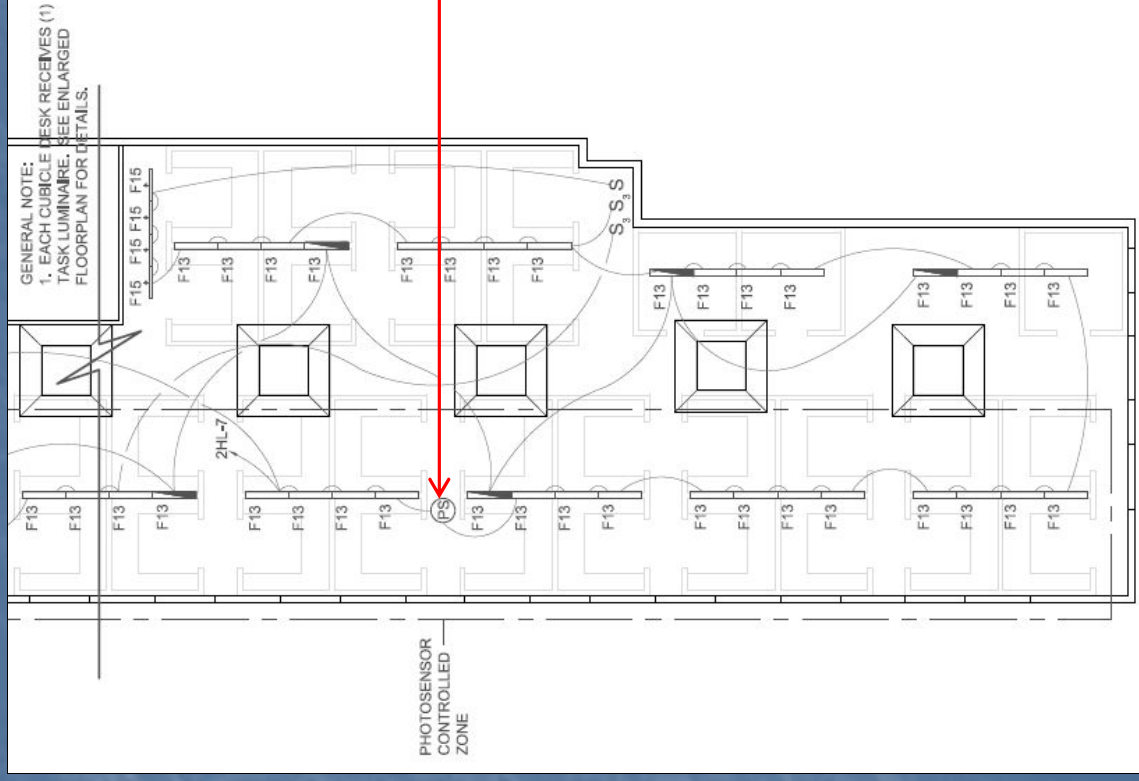
South Layout



LUMINAIRE SCHEDULE			
Type	Description	Lamping	CCT
F13	INDIRECT SUSPENDED LINEAR FLUORESCENT, DOUBLE DIFFUSER OPTICAL DESIGN, 96% REFLECTIVE WHITE PAINT. NOMINAL 3.5"x12"x48". CAN BE CONNECTED IN SECTIONS. TYPE 6 SYMMETRICAL DISTRIBUTION.	(1) F54W/T5/841/ECO	4100
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Lighting Depth: Open Office

Control System

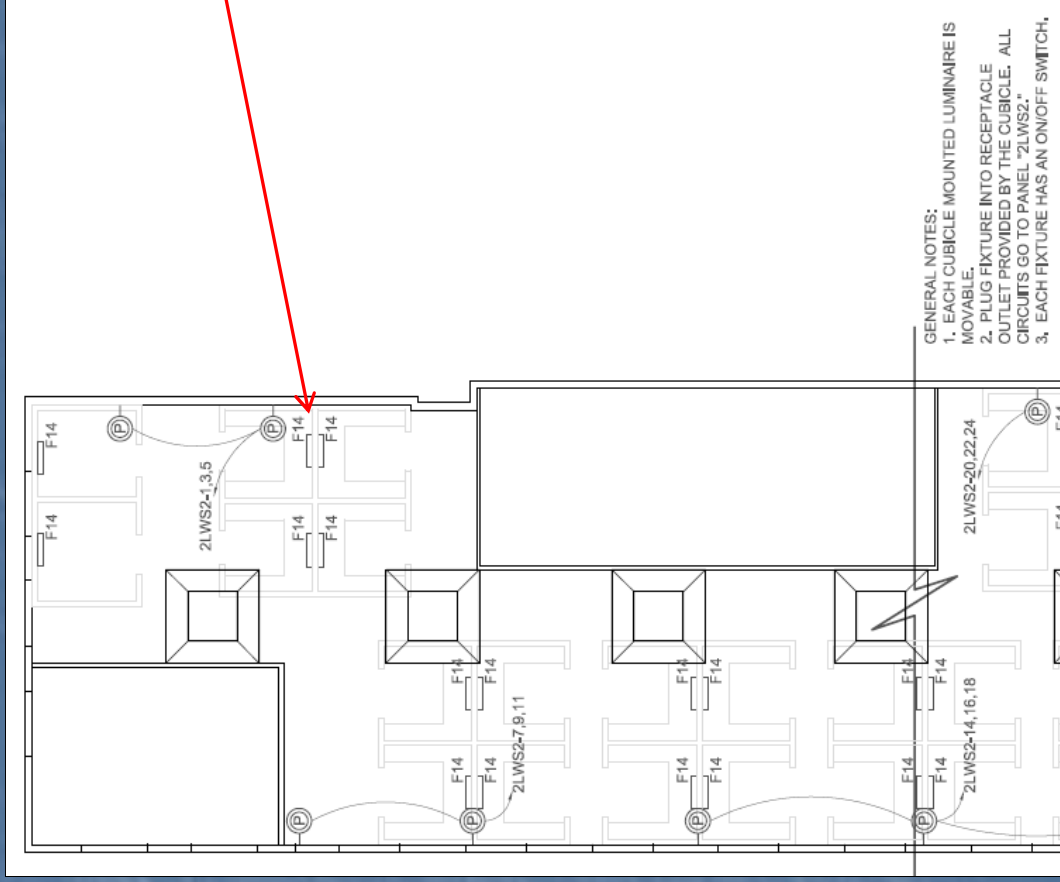


Controls

- The photosensor controls all the suspended luminaires along the west side of the office, dimming them as appropriate
- Override switches are available at the door entrances
- Base SCADA system controls on/off with timers

Lighting Depth: Open Office

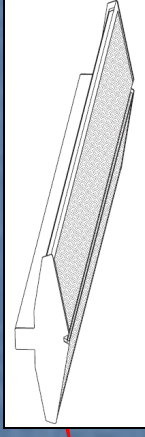
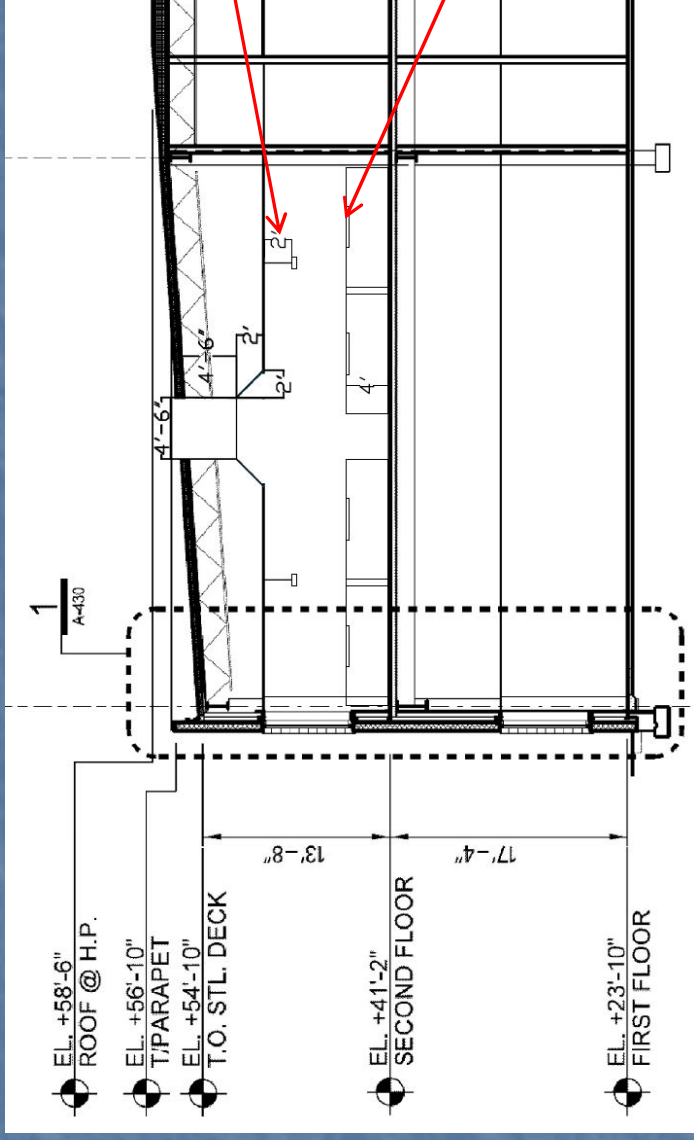
North Layout



LUMINAIRE SCHEDULE			
Type	Description	Lamping	CCT
F13	INDIRECT SUSPENDED LINEAR FLUORESCENT, DOUBLE DIFFUSER OPTICAL DESIGN, 96% REFLECTIVE WHITE PAINT. NOMINAL 3.5"x12"x48". CAN BE CONNECTED IN SECTIONS. TYPE 6 SYMMETRICAL DISTRIBUTION.	(1) F54W/75/841/ECO	4100
F14	WORKSTATION LUMINAIRE FOR INSTALLATION ON OPEN OFFICE FURNITURE PANELS. DESIGNED TO PROVIDE LOW-GLARE TASK LIGHTING FOR HORIZONTAL SURFACES. NOMINAL 6"x2.5"x36". TYPE IV ASYMMETRICAL DISTRIBUTION. PLUG IN CONNECTION TO RECEPTACLE OUTLET.	(1) F21W/75/841/ECO	4100
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Lighting Depth: Open Office

North Elevation



Lighting Depth: Open Office

Renderings



Lighting Depth: Open Office

Renderings

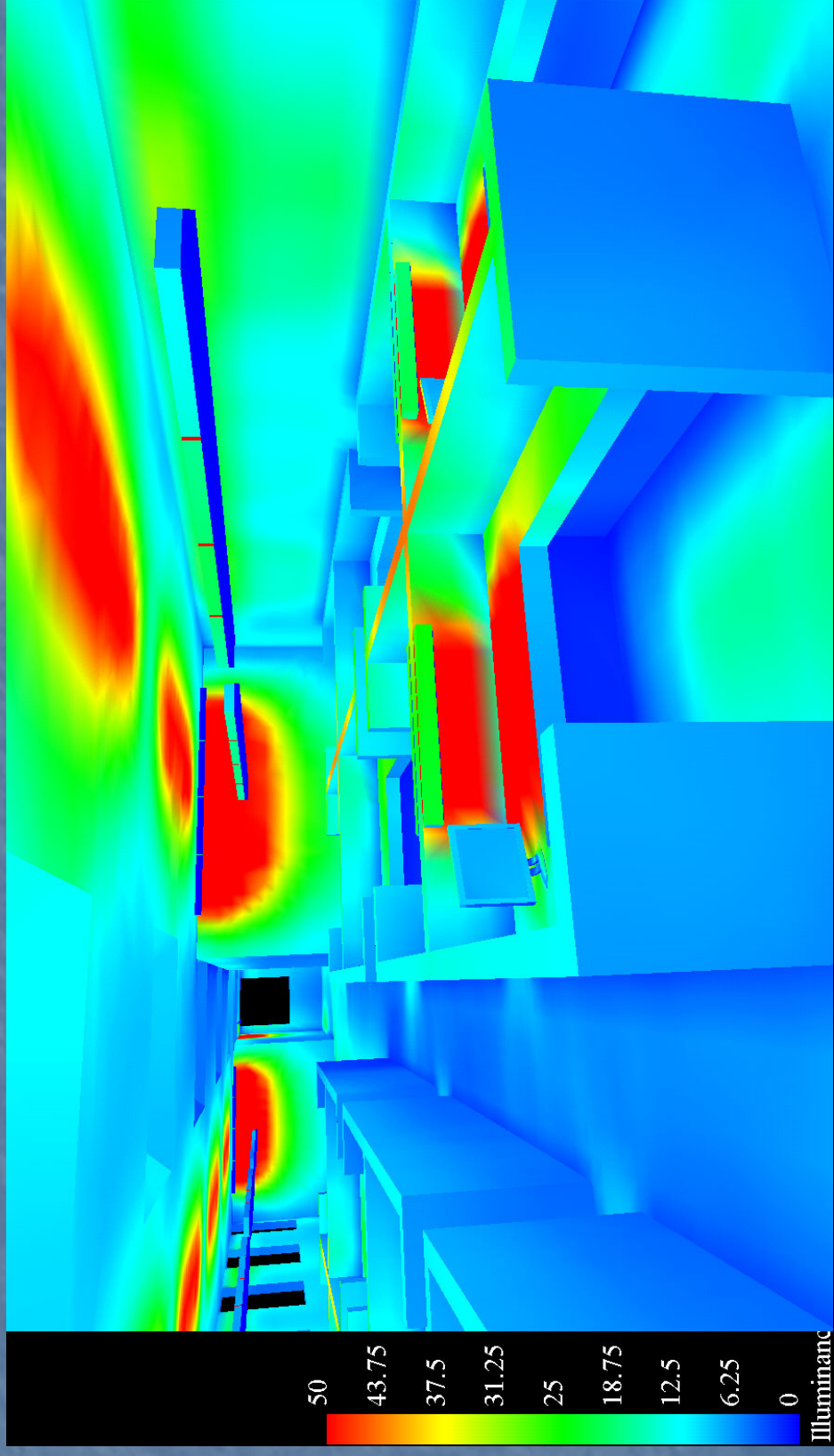


Summary

- Additional daylight provided in the space
- Provided ambient lighting around 30 fc on the workplane
- Provided greater than 50 fc on the workplane with the task luminaires
- Power Density in (W/s.f.) is 0.81 (ASHRAE 90.1 = 1.1) **OK**

Lighting Depth: Open Office

Performance



Outline

Lighting Depth

- Outdoor/Entrance
- Open Office
- Lobby*
- Training theater*

Electrical Depth





- **Uninterruptible Power System (UPS)**
- Photovoltaic Analysis*

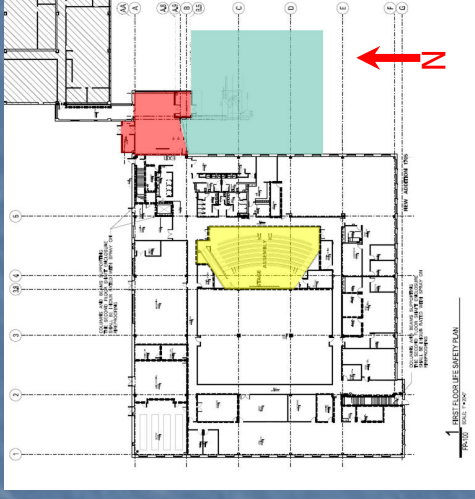
Mechanical Breadth

Construction Management Breadth*

Conclusions

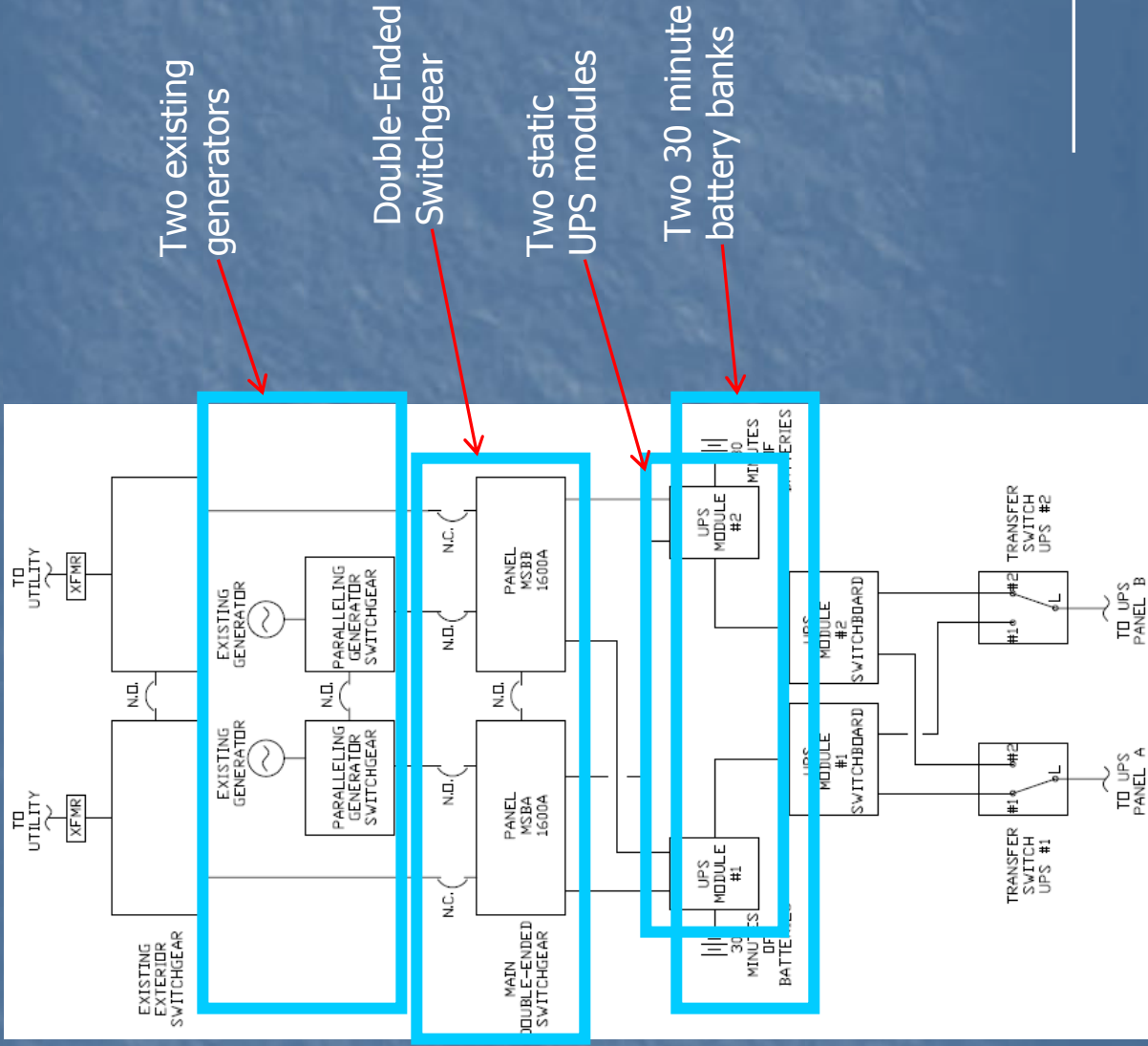
*Topics not covered in presentation

- Outdoor/Entrance: 
- Lobby: 
- Training Theater: 
- Office: 



Electrical Depth: UPS Design

Introduction

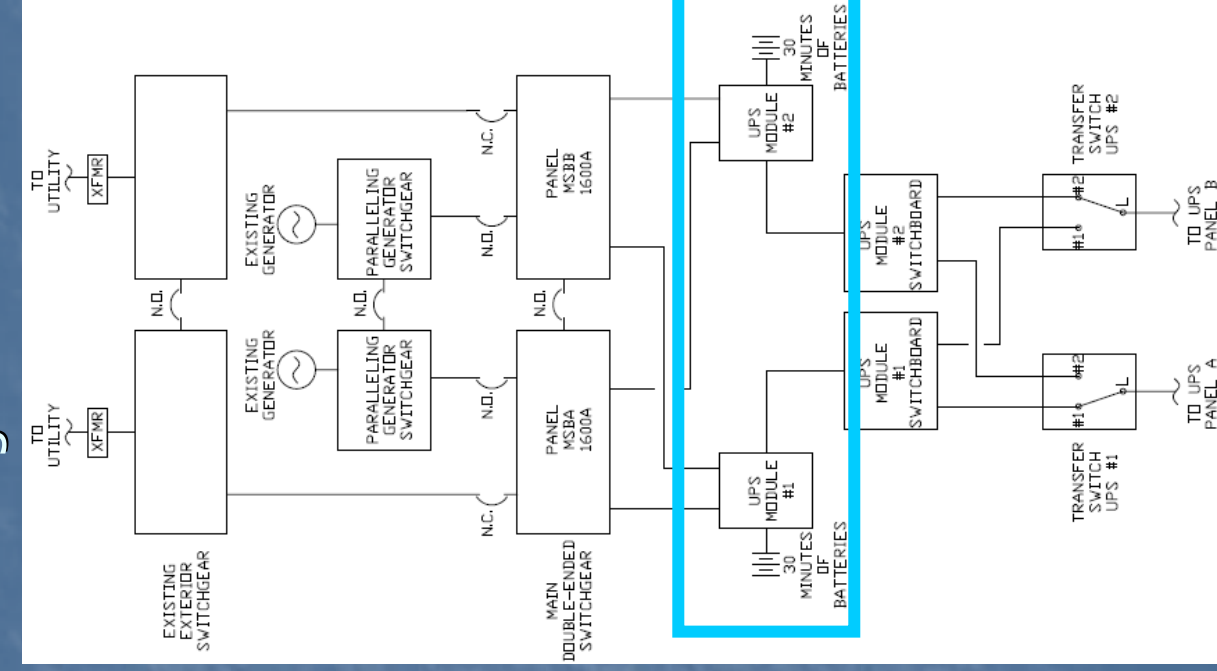


Existing Static UPS system

- Double-ended switchgear, each side can power entire building (1 utility comes in for each)
- Two 625kVA UPS systems, each can power entire UPS load
- Batteries are rated for 30 minutes of emergency power for each UPS module
- Two standby generators, each can power entire UPS load

Electrical Depth: UPS Design

Redesign



Problem

- Existing battery room for the static UPS system takes up a lot of space (1300s.f.)
- Batteries need a lot of maintenance and completely changed out every 5 years
- Room needs extra conditioning to operate batteries at correct temperature
- Environmental concerns

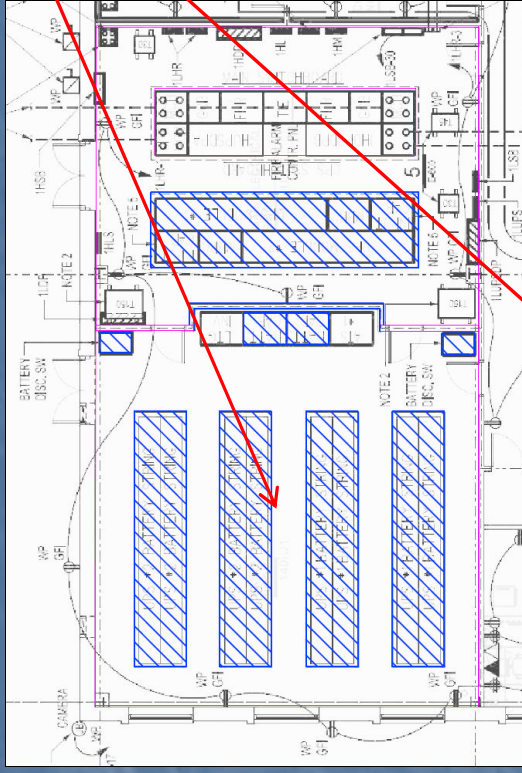
Replace static UPS modules with rotary UPS modules

Proposed Solution

- Use a rotary UPS system
- Uses a flywheel to produce 13 seconds of emergency power
- Generator at full power within 10 seconds

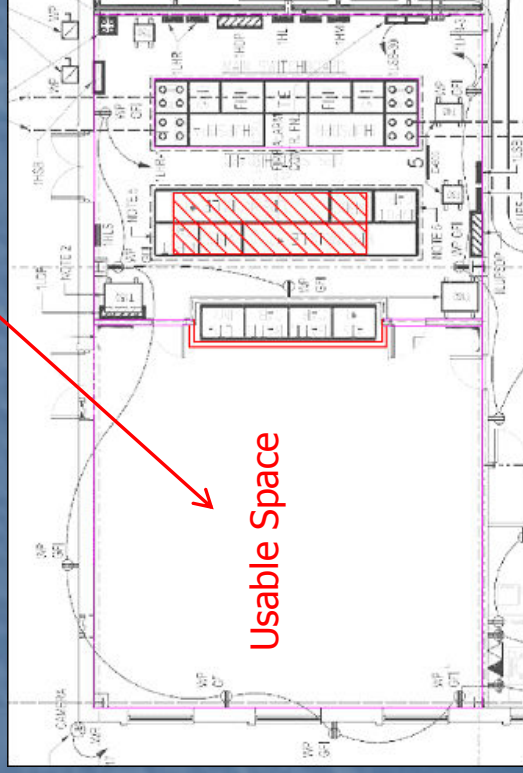
Electrical Depth: UPS Design

Space Savings



Battery Room

Existing Static System with Batteries



Proposed Rotary System



*Entire battery room (1300s.f.) becomes usable space if rotary system is used

Electrical Depth: UPS Design

General UPS System Comparison

UPS Systems

- 600kVA rotary system
- 900kVA rotary system
- 750kVA static system with 7 minutes of battery backup

Comparison of Systems			
	600kVA Rotary UPS	900kVA Rotary UPS	750kVA Static UPS
Power system can produce at full load	13 seconds	13 seconds	7 minutes
Efficiency of system at full load	97%	97%	93%
Yearly Maintenance	\$600	\$900	\$25,000 contract
Replacement Equipment	\$6,000 every 3-5yrs	\$9,000 every 3-5yrs	\$60,000 every 5 yrs
Space Requirements	40s.f.	50s.f.	85s.f.
Max Operating Temperature	104 degrees F	104 degrees F	77 degrees F
Power Factor	0.99	0.99	0.90

Electrical Depth: UPS Design

10 Year Life Cycle Analysis

Present Worth Costs (\$) Over 10 Year Span				
	600kVA Rotary UPS	900kVA Rotary UPS	750kVA Static UPS	
First Cost Equipment	\$230,000	\$340,000	\$200,000	
Installation	\$57,500	\$85,000	\$60,000	
Total First Costs	\$287,500	\$425,000	\$260,000	
Total Savings of each Rotary system compared to the Static System. First Costs, Single System.	-\$27,500	-\$165,000	\$0	
Maintenance	\$4,416	\$6,624	\$184,002	
Replace Equipment (5, 10th year)	\$7,834	\$11,751	\$78,339	
Energy Cost	\$99,677	\$99,677	\$242,617	
Cost of Space	\$66,830	\$83,537	\$142,013	
Present Worth Total 10 Year Cost	\$466,257	\$626,589	\$906,971	
Summary of all Equipment	\$932,514	\$1,253,178	\$1,813,943	
<ul style="list-style-type: none"> Both rotary systems are slightly more expensive in first cost installations 				
Total Savings of each Rotary system compared to the Static System. 10 Year.	\$881,429	\$560,765	\$0	
<ul style="list-style-type: none"> Both rotary systems having a lower life cycle cost than the static system Year: I would recommend either rotary system for easier maintenance, less space for equipment, cheaper long term costs, and more environmentally friendly 				

Outline

Lighting Depth

- Outdoor/Entrance
- Open Office
- Lobby*
- Training theater*

Electrical Depth





- Uninterruptible Power System (UPS)
- Photovoltaic Analysis*

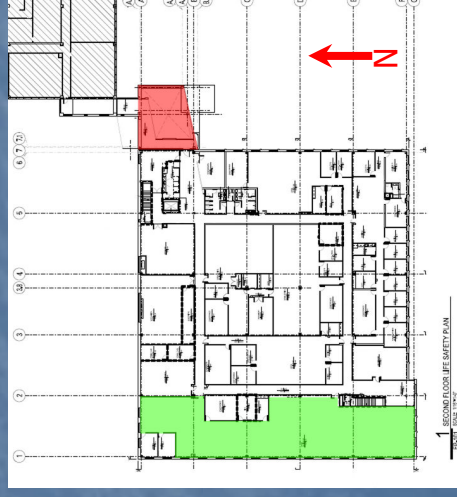
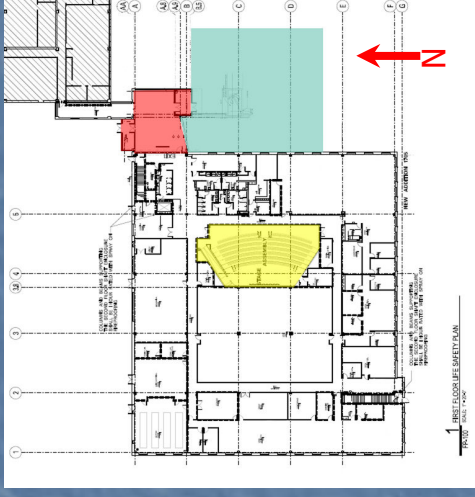
Mechanical Breadth

Construction Management Breadth*

Conclusions

*Topics not covered in presentation

- Outdoor/Entrance: 
- Lobby: 
- Training Theater: 
- Office: 

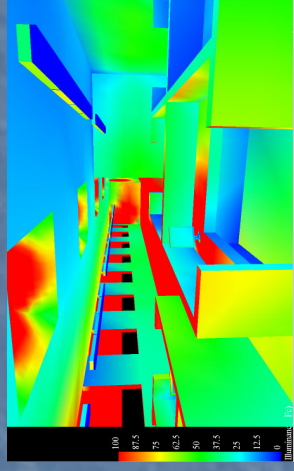


Mechanical Breadth: Skylight affects on HVAC

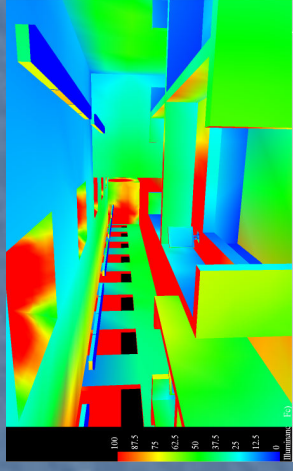
Introduction

Daylight Study

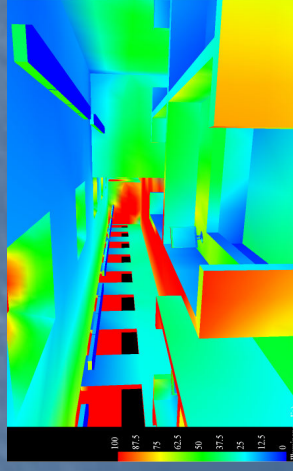
Clear day, June 21, 1pm



Clear day, March 21, 1pm



Clear day, Dec. 21, 1pm



HVAC system

- The additional skylights in the office area change the load requirements of the HVAC system
- The goal is to reduce the lighting needs enough to offset the cost of the additional HVAC loads
- A comparison of the lighting energy saved vs. the HVAC energy used will be the basis of the comparison

Mechanical Breadth: Skylight affects on HVAC

Analysis

HVAC Load Comparison of Additional Skylights using E-Quest and Daylight Savings using SPOT				
	Electrical Consumption per year. HVAC Equipment (kWh)	Electrical Consumption per year. Lighting Equipment (kWh)	Gas Consumption per year (Btu)	Sum
Original Design	912,800	175,200	163,230,000	
Skylight Addition	917,400	175,200	172,510,000	
Difference	4,600	0	9,280,000	
Btu to Therm Conversion	-	-	94.40	
Load in kWh	4,600.00	0.00	-	
Cost	-\$460.00	\$0.00	-\$47.20	-\$507.20
Dimmable Lighting Savings using SPOT	\$239.00	\$452	\$7	\$698.00
Total Savings per year				\$190.80

Assumptions

- Cost of electricity = \$0.10/kwh
- Cost of energy = \$0.50/Therm
- Analysis does not include cost of skylights or dimming equipment

Analysis

- Made E-Quest model
- Use SPOT program to find savings from dimming system

Summary

- The addition of skylights and a dimming system to the office area save energy each year but probably not enough to pay for the extra equipment for dimming and skylights.
- I would still recommend some type of skylight and dimming system for the 2nd floor open office area.

Outline

Lighting Overview

- Lobby
- Training theater

Lighting Depth

- Outdoor/Entrance
- Open Office

Electrical Depth

- Uninterruptible Power System (UPS)
- Photovoltaic Analysis*

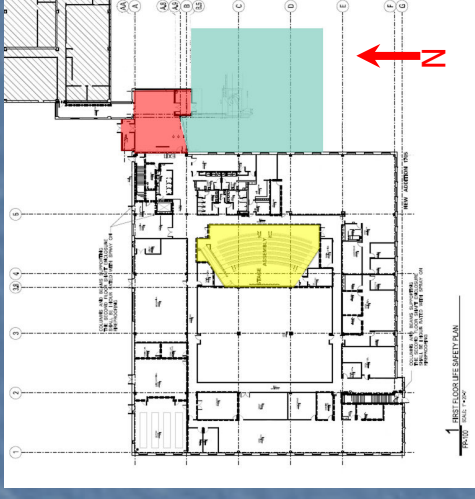
Mechanical Breadth

Construction Management Breadth*

Conclusion

*Topics not covered in presentation

- Outdoor/Entrance:
- Lobby:
- Training Theater:
- Office:



Conclusions

Lighting

- I believe my design met with the architectural design intent of a flexible, efficient, high quality work environment.

Electrical Depth

- The UPS rotary system I feel is a good choice instead of a static UPS system because it saves money in the long run, is easier to maintain, friendlier on the environment and takes up less floor space.

Mechanical Breadth

- The skylight addition in the office may cost more, but occupancy comfort and productivity are increased when quality daylight integration occurs. I would recommend some daylight integration within the open office areas.

Acknowledgements

THANKS TO:

AE Faculty

Dr. Mistrick
Ted Dannerth

Professionals

John Turner, Diane Evans of Kling in Washington D.C.
Brian Guthrie of the NAVFAC Washington
Phil Hollern of Renmark Inc.
Tom Baker of Cleveland Brothers Eq. Co., Inc.

Personal

Family
AE class of 2007

???

Questions?

NNSOC