SHERRERD HALL

PRINCETON UNIVERSITY

JAMIE DEVENGER | THE PENNSYLVANIA STATE UNIVERSITY AE SENIOR THESIS | LIGHTING + ELECTRICAL | 04.14.2010



"LIGHT is a central theme throughout the building. It's a kind of lantern, a lantern of knowledge and circulation." Frederick fisher

OUTLINE BACKGROUND at as COMPUTER SCIENCE PRINCETON UNIVERSITY, NEW JERSEY SITE AND LOCATION HE HEALTH HALL OCCUPANT PRINCETON ORFE AND CITP DEPARTMENTS CHARLTON ST. 47,000 SQUARE FEET BACKGROUND INFORMATION INTRODUCTION 4 (3 ABOVE GRADE) 0 FREDERICK FISHER AND PARTNERS 0 LIGHTING DESIGNER FISHER MARANTZ STONE T T TT MEP ENGINEER JOSEPH LORING ENGINEERS 8 1 ROBERT SILMAN ASSOCIATES CURTAIN WALL W.J. HIGGINS AND ASSOCIATES BARR & BARR, INC., BUILDERS MUDD

OUTLINE ARCHITECT 10 PHILOSOPHY A BUILDING HAS A COLLAGE-LIKE NATURE AS AN HIS STATE of 1 14 hours His sections ASSEMBLAGE OF USE, BACKGROUND INFORMATION INTRODUCTION ARCHITECTURAL CONCEPT MATERIAL, AND LIGHT

"A BRIDGE BETWEEN SOCIAL SCIENCES AND ENGINEERING," FREDERICK FISHER

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OUTLINE	INTRODUCTION	DESIGN SCOPE	SPRING SEMESTER STUDIES
		LIGHTING DESIGN	LOBBY ATRIUM STAIR FAÇADE AND PERIMETER OFFICES
	BACKGROUND INFORMATION ARCHITECTURAL CONCEPT		LECTURE HALL OPEN WORK SPACE GRADUATE BULLPEN I
LIGHTING DESIGN DAYLIGHTING	SCOPE OF REDESIGN	DAYLIGHTING	NORTHWEST PERIMETER OFFICES GRADUATE BULLPEN I
MECHANICAL LOADS		ELECTRICAL DESIGN	ATRIUM SKYLIGHT FIVE SPACES
ELECTRICAL DESIGN			COPPER VERSUS ALUMINUM FEEDERS ON-SITE GENERATOR DESIGN
CONCLUSION		MECHANICAL LOADS STRUCTURAL DESIGN	PERIMETER OFFICES + ATRIUM SKYLIGHT ROOF FRAMING FOR ATRIUM SKYLIGHT

OUTLINE		DESIGN SCOPE	PRESENTED TODAY
		LIGHTING DESIGN	LOBBY ATRIUM STAIR FAÇADE AND PERIMETER OFFICES
			LECTURE HALL
INTRODUCTION	BACKGROUND INFORMATION ARCHITECTURAL CONCEPT		OPEN WORK SPACE
LIGHTING DESIGN	SCOPE OF REDESIGN		GRADUATE BULLPEN I
		DAYLIGHTING	NORTHWEST PERIMETER OFFICES
DAYLIGHTING			GRADUATE BULLPEN I
			ATRIUM SKYLIGHT
MECHANICAL LOADS		ELECTRICAL DESIGN	FIVE SPACES
ELECTRICAL DESIGN			COPPER VERSUS ALUMINUM FEEDERS
LELCINCAL DEGION			ON-SITE GENERATOR DESIGN
CONCLUSION		MECHANICAL LOADS	PERIMETER OFFICES + ATRIUM SKYLIGHT
		STRUCTURAL DESIGN	ROOF FRAMING FOR ATRIUM SKYLIGHT

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INTRODUCTION

LIGHTING DESIGN NORTHWEST FAÇAD OPEN WORK SPACE

GENERAL LIGHTING CONCEPTS

DAYLIGHIIN

MECHANICAL LOAD

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CONCLUSION

LIGHTING DESIGN GENERAL CONCEPTS

LIGHT AS A METAPHOR FOR KNOWLEDGE AND OPENNESS

LIGHT FILTERED THROUGH TRANSPARENT AND TRANSLUCENT ENCLOSURES

LIGHT TO SIMULATE MOVEMENT AND ENERGY FOR CIRCULATION





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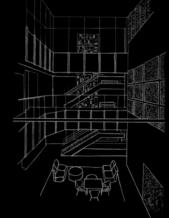
GENERAL LIGHTING CONCE LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

MECHANICAL LOAD

ELECTRICAL DESIGN

CONCLUSION

LIGHTING DESIGN LOBBY ATRIUM STAIR



ARCHITECTURE

3 STORY ATRIUM CORE ADMITS LIGHT TRANSPARENT MATERIALS VERTICAL BRIDGING

SPACE USE MAIN ENTRANCE GATHERING SPACE LOUNGE AREAS AT EACH LEVEL PRIMARY CIRCULATION PATH PRIMARY OPEN STAIR



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INTRODUCT

LIGHTING DESIGN

GENERAL LIGHTING CONCE LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

1ECHANICAL LOA

ELECTRICAL DESIGN

CONCLUSION

LIGHTING DESIGN LOBBY ATRIUM STAIR

DESIGN GOALS

MEET IESNA RECOMMENDATIONS AND ASHRAE STANDARD 90.1

ENHANCE ARCHITECTURE AND MATERIALS

REINFORCE BUILDING FUNCTIONS:

CORE PULSES WITH ENERGY AND MOVEMENT TRANSPARENCY ALLOWS FOR INTERACTION IDEAS AND LIGHT EXPAND THROUGH HE CORE



OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN	LOBBY ATRIUM STAIR	
INTRODUCTION	GENERAL LIGHTING CONCEPTS			
LIGHTING DESIGN	LOBBY ATRIUM STAIR NORTHWEST FAÇADE OPEN WORK SPACE			
DAYLIGHTING				
MECHANICAL LOADS				
ELECTRICAL DESIGN				
CONCLUSION				

LIGHTING DESIGN

LOBBY | ATRIUM | STAIR

DAYLIGHTI

MECHANICAL LOAD

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CONCLUSION

LIGHTING DESIGN LOBBY ATRIUM STAIR



(1) 35W MH PAR 20 SURFACE-MOUNTED SPOTLIGHT



INTRODUCTION

LOBBY | ATRIUM | STAIR

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MECHANICAL LOAD

ELECTRICAL DESIGN

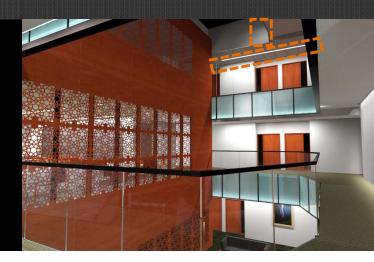
CONCLUSION

LIGHTING DESIGN LOBBY ATRIUM STAIR



(I) 35W MH PAR 20 SURFACE-MOUNTED SPOTLIGE





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GENERAL LIGHTING CONCEP LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

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LIGHTING DESIGN LOBBY ATRIUM STAIR



(1) 35W MH PAR 20 SURFACE-MOUNTED SPOTLIG



FLEXIBLE LED SLOT-MOUNTED GRAZING





LIGHTING DESIG





LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

MECHANICAL LOAD

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(1) F28T5 recessed, lensed downlight

FLEXIBLE LED SLOT-MOUNTED GRAZING

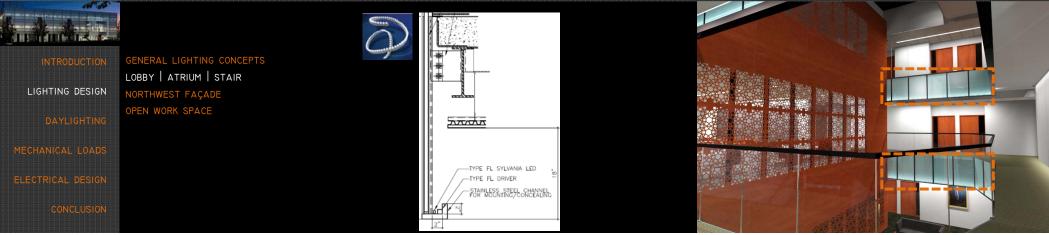


FLEXIBLE LED CHANNEL-MOUNTED GRAZING



OUTLINE LIGHTING DESIGN

LIGHTING DESIGN LOBBY | ATRIUM | STAIR



OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN LOBBY ATRIUM STAIR	
And I			
08	GENERAL LIGHTING CONCEPTS		
	LOBBY ATRIUM STAIR NORTHWEST FAÇADE		
DAYLIGHTING	OPEN WORK SPACE		
MECHANICAL LOADS			
ELECTRICAL DESIGN			
CONCLUSION			

LIGHTING DESIGN LOBBY ATRIUM STAIR



LOBBY | ATRIUM | STAIR

LIGHTING DESIGN





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LOBBY | ATRIUM | STAIR

INTRODUCTION LIGHTING DESIGN

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CONCLUSION

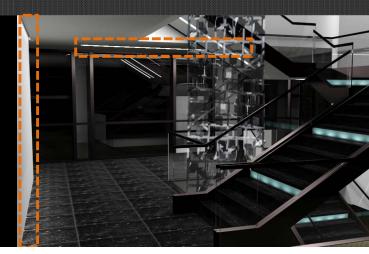
LIGHTING DESIGN LOBBY ATRIUM STAIR



(1) F28T5 RECESSED, LENSED DOWNLIG



FLEXIBLE LED SLOT-MOUNTED GRAZING



OUTLINE AFA

IGHTING DESIGN

LIGHTING DESIGN LOBBY ATRIUM STAIR



GENERAL LIGHTING CONCEP LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

LIGHTING DESIGN

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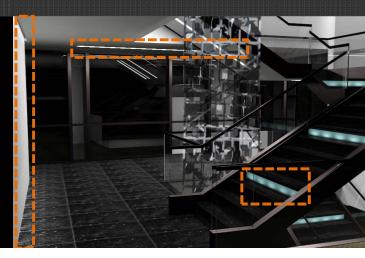
CONCLUSION



FLEXIBLE LED SLOT-MOUNTED GRAZING

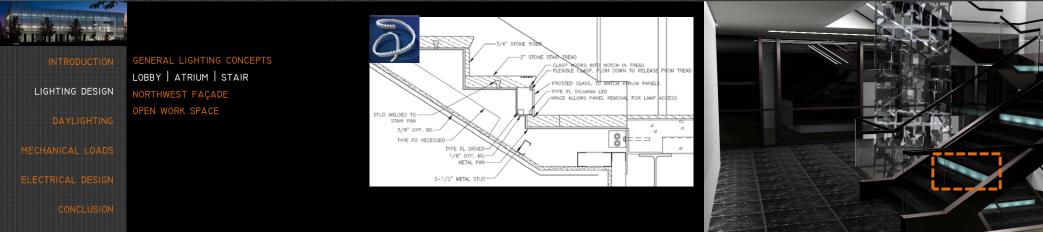


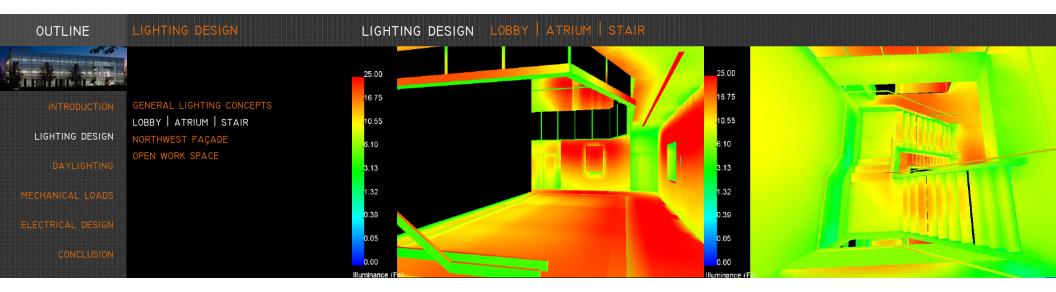
FLEXIBLE LED CHANNEL-MOUNTED GRAZING



OUTLINE LIGHTING DE

LIGHTING DESIGN LOBBY ATRIUM STAIR







OUTLINE LIGHTING DESIGN LIGHTING DESIGN LOBBY | ATRIUM | STAIR INTRODUCTION LIGHTING DESIGN KNERAL LIGHTING CONCEPTS LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE INTRODUCTION LIGHTING DESIGN INTRODUCTION LIGHTING DESIGN DAYLIGHTING CONCLUSION INTRODUCTION LIGHTING DESIGN INTRODUCTION LIGHTING DESIGN NORTHWEST FAÇADE OPEN WORK SPACE INTRODUCTION LIGHTING DESIGN INTRODUCTION LIGHTING DESIGN DAYLIGHTING CONCLUSION INTRODUCTION LIGHTING DESIGN INTRODUCTION LIGHTING DESIGN INTRODUCTION LIGHTING DESIGN

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LIGHTING

GENERAL LIGHTING CONCEPTS

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LIGHTING DESIGN

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LIGHTING DESIGN LOBBY | ATRIUM | STAIR

DESIGN SUMMARY

ENHANCE ARCHITECTURE AND MATERIALS: LUMINAIRES SIMPLE, ORTHOGONAL, CONCEALED; BACKLIGHTING OF TRANSLUCENT PANELS AND FEATURE WALL

TRANSPARENCY

ENERGY AND MOVEMENT: LINEAR LUMINAIRES EVOKE MOVEMENT IN OPEN STAIR

EXPANSION: WALL AND PANEL GRAZING EVOKES EXPANSION

DESIGN SUMMARY

DESIGN MEETS IESNA RECOMMENDATIONS (SEE PS IMAGES)

- + 5 FC HORIZONTAL IN CORRIDOR/STAIR
- + 10 FC HORIZONTAL IN LOBBY

DESIGN MEETS ASHRAE 90.1 WITH TRADABLE WATTS

SPACE TYPE	POWER ALLOWANCE (W)	DESIGN (W)	DECORATIVE (W)	ENERGY CODE
LOBBY	1698.5	886.0	0	MEETS
CORRIDOR	3247.6	4357.0	0	EXCEEDS
STAIRS-ACTIVE	501.0	751.5	192.5	EXCEEDS
ATRIUM	694.7	441.0	0	MEETS

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NORTHWEST FAÇADE

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LIGHTING DESIGN NORTHWEST FAÇADE

DESIGN GOALS

MEET IESNA RECOMMENDATIONS AND ASHRAE STANDARD 90.1 ENHANCE ARCHITECTURE AND MATERIALS CONSIDER INTERIOR SURFACE LUMINANCE AND DISTRIBUTION REINFORCE DEPARTMENT IDEALS: CONSTANTLY EVOLVING AESTHETIC

BI-DIRECTIONAL TRANSMISSION OF LIGHT AND IDEAS BUILDING PULSES WITH ENERGY AND MOVEMENT





OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN NORTHWEST FAÇADE	OFFICE LIGHTING OFF
	GENERAL LIGHTING CONCEPTS LOBBY ATRIUM STAIR		
LIGHTING DESIGN	NORTHWEST FAÇADE		
DAYLIGHTING	OPEN WORK SPACE		
MECHANICAL LOADS			
ELECTRICAL DESIGN			
CONCLUSION			



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	LOBBY ATRIUM STA
LIGHTING DESIGN	NORTHWEST FAÇADE
	OPEN WORK SPACE
DAYLIGHTING	

LIGHTING DESIGN NORTHWEST FAÇADE

OFFICE LIGHTING OFF





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NORTHWEST FAÇADE

LIGHTING DESIGN NORTHWEST FACADE



FLEXIBLE LED CHANNEL-MOUNTED GRAZING

LINEAR LED SLOT-MOUNTED GRAZING

OFFICE LIGHTING OFF



OUTLINE LIGHTING DESIGN NORTHWEST FACADE OFFICE LIGHTING OFF 100 1/4" TEMPERED, ACID-ETCHED GLASS Historia I the Instance 1.00 DOUBLE LAYER OF PPG -SOLARBAN 70XL, CERAMIC FRIT 1 LIGHTING DESIGN NORTHWEST FAÇADE Electron and a second TYPE FL SYLVANIA LED-CHANNEL TO CONCEAL LED-

OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN NORTHWEST FACADE	OFFICE LIGHTING ON
Contraction of the			
	GENERAL LIGHTING CONCEPTS		
	LOBBY ATRIUM STAIR NORTHWEST FAÇADE		
DAYLIGHTING	OPEN WORK SPACE		
MECHANICAL LOADS			
ELECTRICAL DESIGN			
CONCLUSION			



LIGHTING DESIGN

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NORTHWEST FAÇADE

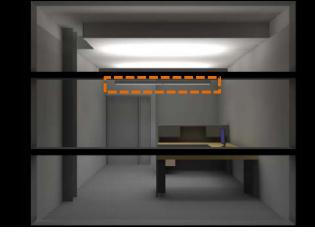


G	ihtin	IG DE	SIGN	NO	RTHW	ESTI

OFFICE LIGHTING ON



F28T5 SUSPENDED INDIRECT-DIRECT PENDANT





OUTEINE

- Andrew

LOBBY | ATRIUM | ST LIGHTING DESIGN NORTHWEST FAÇADE

OPEN WORK SPACE

DAYLIGHTIN

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LIGHTING DESIGN NORTHWEST FAÇADE

DESIGN SUMMARY

ENHANCE ARCHITECTURE AND MATERIALS: BACKLIGHTING OF TRANSLUCENT PANELS TO CREATE GLOW

CONSIDER INTERIOR LUMINANCE AND DISTRIBUTION: OFFICE LIGHTING ILLUMINATES CEILING AND TOP OF WALLS

TRANSPARENCY: BACKLIGHTING PEOPLE /OBJECTS AT FIRST LEVEL

ENERGY AND MOVEMENT: RANDOM PANEL ILLUMINATION EVOKES MOVEMENT, DRAMA, AND EXCITEMENT

DESIGN SUMMARY

DESIGN MEETS IESNA RECOMMENDATIONS (SEE PS IMAGES)

SPACE TYPE	CALCULATION	CRITERIA (FC)	DESIGN (FC)	IESNA
PRIVATE	HOR. 2.5'	.30	29.66	MEETO
OFFICE		50	29.00	MEETS

DESIGN MEETS ASHRAE 90.1

SPACE TYPE	POWER	DESIGN	DECORATIVE	ENERGY
	ALLOWANCE (W)	(W)	(W)	CODE
OFFICE- ENCLOSED	5337.1	5273.3	0	MEETS

LIGHTING DESIGN

GENERAL LIGHTING CONCEPT LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

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LIGHTING DESIGN OPEN WORK SPACE



ARCHITECTURE TRANSPARENCY TO BUILDING CORE OPEN AND FLEXIBLE

SPACE USE

ACADEMIC LECTURES STUDY SESSIONS ENTERTAINING DEPARTMENT EVENTS



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DESIGN GOALS

MEET IESNA RECOMMENDATIONS AND ASHRAE STANDARD 90.1 ENHANCE ARCHITECTURE AND MATERIAL PROPERTIES PROVIDE A FLEXIBLE SOLUTION

EVOKE FLYNN PUBLIC AND RELAXATION IMPRESSIONS







RELAXATION

OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN OPEN WORK SPACE	PUBLIC IMPRESSION
	GENERAL LIGHTING CONCEPTS LOBBY ATRIUM STAIR		
LIGHTING DESIGN	NORTHWEST FAÇADE		Transferra Landa Landa
DAYLIGHTING	OPEN WORK SPACE		
MECHANICAL LOADS			
ELECTRICAL DESIGN			
CONCLUSION			

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OPEN WORK SPACE

LIGHTING DESIGN OPEN WORK SPACE



F28T5 RECESSED, LENSED DOWNLIGHT

PUBLIC IMPRESSION



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LIGHTING DESIGN OPEN WORK SPACE





(I) F28T5 RECESSED, LENSED DOWNLIGH

(I) 42W PL-T CFL

I) 42W PL-T CFL RECESSED DOWNLIGH

PUBLIC IMPRESSION





GHTING DESIGN

OPEN WORK SPACE



PUBLIC IMPRESSION



LIGHTING DESIGN

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MECHANICAL LOAD

ELECTRICAL DESIGN









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LIGHTING DESIGN OPEN WORK SPACE

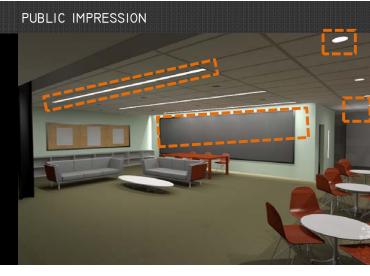




(I) 42W PL-T CFL RECESSED DOWNLIG

(I) 42W PL-T CFL RECESSED WALLWA

LED SLOT-MOUNTED GRAZING



OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN OPEN WORK SPACE	RELAXATION IMPRESSION
Cantantanta			
	GENERAL LIGHTING CONCEPTS LOBBY ATRIUM STAIR		
LIGHTING DESIGN	NORTHWEST FAÇADE OPEN WORK SPACE		
DAYLIGHTING	UPEN WURN SPACE		
MECHANICAL LOADS			
ELECTRICAL DESIGN			
CONCLUSION			



LIGHTING DESIC

LIGHTING DESIGN OPEN WORK SPACE



(I) 42W PL-T CFL RECESSED DOWNL

OPEN WORK SPACE

MECHANICAL LOADS

LIGHTING DESIGN

ELECTRICAL DESIGN



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LIGHTING DESIGN OPEN WORK SPACE



(I) 42W PL-T CFL RECESSED DOWNLIGHT



42W FL-1 CIL RECESSED WALLWASHE

RELAXATION IMPRESSION



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LIGHTING DESIGN

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OPEN WORK SPACE

MECHANICAL LOAD

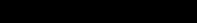
ELECTRICAL DESIGN

CONCLUSION

LIGHTING DESIGN OPEN WORK SPACE







(I) 50W PAR 36 HALOGEN SPOTLIGHT





GENERAL LIGHTING CONC LOBBY | ATRIUM | STAIR NORTHWEST FAÇADE OPEN WORK SPACE

LIGHTING DESIGN

ELECTRICAL DESIGN

CONCLUSION

LIGHTING DESIGN OPEN WORK SPACE



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(I) 42W PL-T CFL RECESSED WALLWASHER

(I) 42W TE TOTE RECESSED WALLY

(I) 50W PAR 36 HALOGEN SPOTLIGHT



RELAXATION IMPRESSION

(I) 20W MR-II HALOGEN SPOTLIGHT



OPEN WORK SPACE

LIGHTING DESIGN



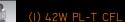


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LIGHTING DESIGN OPEN WORK SPACE







RELAXATION IMPRESSION



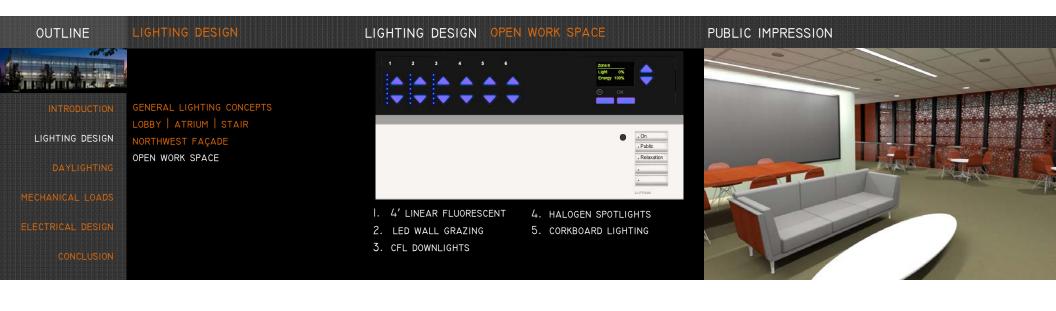
LED SLOT-MOUNTED GRAZING

OUTLINE LIGHTING DESI	GN LIGHTING DESIGN OPEN	WORK SPACE PUBLIC IMPRESS	ION
INTRODUCTION LIGHTING DESIGN DAYLIGHTING MECHANICAL LOADS ELECTRICAL DESIGN CONCLUSION	STAIR DE 12.21	50.00 33.50 21.09 12.21 6.25 2.64 0.78 0.10 0.00	

OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN OPEN WORK SPACE	RELAXATION IMPRESSION
			20.00
K080804040808040408080804040808040408080404080808080	GENERAL LIGHTING CONCEPTS LOBBY ATRIUM STAIR	8.44	8.44
	NORTHWEST FAÇADE	4.88	
DAYLIGHTING	OPEN WORK SPACE	2.50	2.50
MECHANICAL LOADS		1.05	1.05
ELECTRICAL DESIGN		0.31	0.31
CONCLUSION			0.04
		0.00 December 2000	0.00 Illuminance (Fe)

OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN OPEN WORK SPACE	PUBLIC IMPRESSION
(Andreas		1 2 3 4 5 6 Zone Light of Energy 100 C	
	GENERAL LIGHTING CONCEPTS LOBBY ATRIUM STAIR		
LIGHTING DESIGN	NORTHWEST FAÇADE	• On • Public	
DAYLIGHTING	OPEN WORK SPACE	- Relaxation	
MECHANICAL LOADS		I. 4' LINEAR FLUORESCENT 4. HALOGEN SPOTLIGHTS	
ELECTRICAL DESIGN		2. LED WALL GRAZING 5. CORKBOARD LIGHTING	
CONCLUSION		3. CFL DOWNLIGHTS	





OUTLINE	LIGHTING DESIGN	LIGHTING DESIGN OPEN WORK SPACE	RELAXATION IMPRESSION
		1 2 3 4 5 6 Zona 5 Light 100% Swings 10%	
04	GENERAL LIGHTING CONCEPTS LOBBY ATRIUM STAIR		
LIGHTING DESIGN	NORTHWEST FAÇADE OPEN WORK SPACE	On Public Relaxation ·	
MECHANICAL LOADS		I. 4' LINEAR FLUORESCENT 4. HALOGEN SPOTLIGHTS	14/5
ELECTRICAL DESIGN		2. LED WALL GRAZING 5. CORKBOARD LIGHTING	
CONCLUSION		3. CFL DOWNLIGHTS	

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LIGHTING DESIGN OPEN WORK SPACE

DESIGN SUMMARY

ENHANCE ARCHITECTURE AND MATERIALS: LUMINAIRES ALL

CONTAINED IN CEILING PLANE; SHADOWING WITH FEATURE WALL

FLEXIBLE SOLUTION: DIGITAL CONTROL SYSTEM ALLOWS FOR QUICK RECALL OF TWO DESIGN SOLUTIONS; ON/OFF/DIM OF EACH ZONE PROVIDES ADDITIONAL FLEXIBILITY

PUBLIC IMPRESSION: DIFFUSE, OVERHEAD LIGHTING WITH HIGHER LIGHT LEVELS

RELAXATION IMPRESSION: SOFT POOLS OF LIGHT, PERIPHERAL EMPHASIS, LOWER LIGHT LEVELS

DESIGN SUMMARY

DESIGN MEETS IESNA RECOMMENDATIONS

SPACE TYPE	CALCULATION	CRITERIA (FC)	DESIGN (FC)	IESNA
GEN CLASS	HOR. 2.5'	30	35	MEETS
GEN CLASS	VERTICAL	50	45	UNDER

DESIGN MEETS ASHRAE 90.1 WITH TRADABLE WATTS

SPACE TYPE	POWER	DESIGN	DECORATIVE	ENERGY
	ALLOWANCE (W)	(W)	(W)	CODE
CLASS/LECTURE /TRAINING	1243.2	1442	92.6	EXCEEDS

OUTLINE	DAYLIGHTING	DAYLIGHTING NORTHWEST PERIMETER OFFICES	
	PERIMETER OFFICES NORTHWEST FAÇADE	OBJECTIVES 1. IMPROVE QUALITY OF DAYLIGHT DELIVERY SYSTEM BY MODIFYING THE CURTAINWALL SYSTEM	35.00 23.45
LIGHTING DESIGN		2. PROVIDE A CLOSED LOOP PROPORTIONAL DAYLIGHT RESPONSIVE DIMMING SYSTEM TO SAVE ENERGY THROUGHOUT THE YEAR	14.77 8.54 Typical 2 ND and 3 RD FLOOR OFFICE (SOME
DAYLIGHTING		SPECIFICS LOCATION: PRINCETON, NEW JERSEY	4.38 ARE DOUBLE SIZE) WITH
MECHANICAL LOADS		LATITUDE: 40.37	
ELECTRICAL DESIGN		Longitude: 74.67 Electric lighting: indirect-direct pendant (T5-2900 LM)	0.07
CONCLUSION		TARGET ILLUMINANCE: 30 FC	0.00 Illuminance (Fc)

OUTLINE DAYLIC

DAYLIGHTING NORTHWEST PERIMETER OFFICES

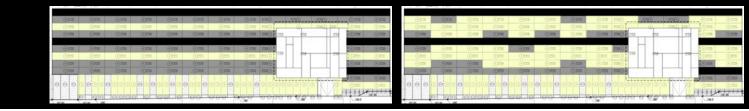
EXISTING CURTAINWALL SYSTEM

COMBINATION OF OPAQUE, TRANSLUCENT, AND FRITTED SPANDREL PANELS: BLACK: OPAQUE PANEL

GREY: TRANSLUCENT PANEL YELLOW: FRITTED PANEL, GLASS VISIBLE ${\cal T}~$ = 0.70

MODIFIED CURTAINWALL SYSTEM IMPROVES QUALITY

30 TRANSLUCENT PANELS REPLACED WITH FRITTED TO INCREASE VIEWS AND REDUCE GLARE FROM GLOWING TRANSLUCENT PANELS. YELLOW: FRITTED PANEL, GLASS VISIBLE τ = 0.64, EFF τ = 0.62 (PPG SOLARBAN 70XL TO IMPROVE THERMAL PERFORMANCE)



INTRODUCTION	PERIMETER OFFICES NORTHWEST FAÇADE
LIGHTING DESIGN	
DAYLIGHTING	
MECHANICAL LOADS	
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OUTLINE DAYLIGH

AYLIGHTING

DAYLIGHTING NORTHWEST PERIMETER OFFICE

INTRODUCTION PERIMETER OFFICES | NORTHWEST FAÇADE

DAYLIGHTING

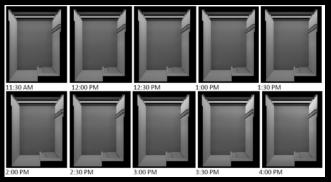
MECHANICAL LOADS

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DIRECT SOLAR PENETRATION STUDIES

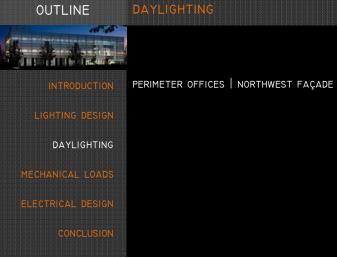
DECEMBER 21



NO PROBLEM WITH DIRECT SUN IN THE WINTER: SUN IS BELOW THE HORIZON BY THE TIME IT COMES BACK AROUND THE BUILDING TO FACE THE NORTHWEST FAÇADE

DAYLIGHTING NORTHWEST PERIMETER OFFIC

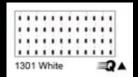
DIRECT SOLAR PENETRATION STUDIES



MARCH 2I

DIRECT SUN IS A PROBLEM FROM 3:30 TO 5:30 PM.

a shade must be provided to prevent direct glare: thermovel white [30] visible $\tau~$ = 0.11, openness factor = 0.06



DAYLIGHTING



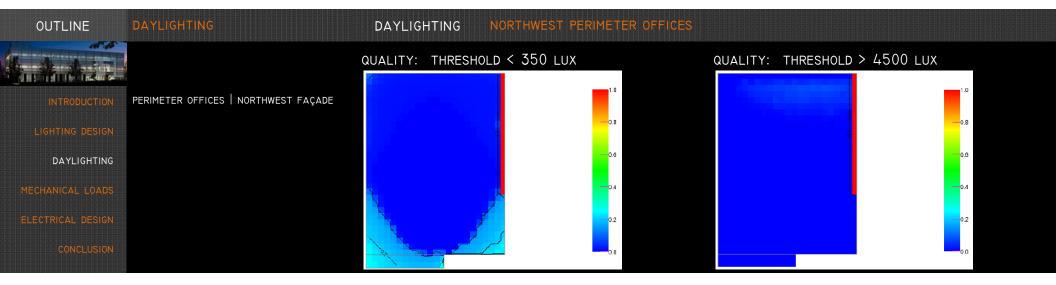
OUTLINE

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2:30 PM 3:00 PM 3:30 PM 4:00 PM 5:00 PM 4:30 PM 5:30 PM 6:00 PM 6:30 PM

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OUTLINE	DAYLIGHTING		DRTHWEST	PERIMETER	OFFICES		
INTRODUCTION	PERIMETER OFFICES NORTHWEST FAÇADE	CONTROL SYSTEM CLOSED LOOP PROPORTIONAL D PHOTOSENSOR ON CEILING IN (0008 6000 (KH) 4000	BASE LOAD
LIGHTING DESIGN		TOTAL ENERGY SAVING	SS OVER S	COPE OF RED	ESIGN	μ μ	LOAD WITH DAYLIGHTING
DAYLIGHTING		SPACE	BASE LOAD (KWH)	ENERGY SAVINGS (KWH)	PERCENT SAVINGS	2000 ANNU	
MECHANICAL LOADS		GRADUATE BULLPEN I	1008.30	517.05	51.28%		
		NW OFFICES ALL CLEAR	1931.92	1534.05	79.41%	E BUILT AL CHAR BHUSE ON OFFICE	COR.
ELECTRICAL DESIGN		NW OFFICES TOP DIFFUSE	1655.94	1158.42	70.0%	the man to the top	
		NW OFFICES BOTTOM DIFFUSE	2483.91	1961.37	78.96%	appurt in hun port toth	
CONCLUSION		TOTAL SCOPE OF REDESIGN	7080.08	5170.89	73.03%		



MECHANICAL LOA

MECHANICAL NORTHWEST CURTAINWALL

OBJECTIVES

 IMPROVE QUALITY OF DAYLIGHT DELIVERY SYSTEM BY REPLACING 30 TRANSLUCENT SPANDREL PANELS WITH FRITTED PANELS

2. MINIMIZE THE THERMAL IMPACT OF CURTAINWALL MODIFICATIONS

PANEL THERMAL PROPERTIES

MATERIAL	U-VALUE (BTU/HR-FT2-DEG F)	SHADING COEFFICIENT
OPAQUE PANEL (BLACK)	0.1	N/A
TRANSLUCENT PANEL (GREY)	0.25	0.2
FRITTED PANEL (YELLOW)	0.32	0.47

EXISTING NORTHWEST CURTAINWALL



PROPOSED NORTHWEST CURTAINWALL



NORTHWEST CURTAINWALL SYSTEM SOUTHWEST CURTAINWALL SYSTEM ATRIUM SKYLIGHT SUMMARY LOADS

MECHANICAL LOADS

OUTLINE

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ELECTRICAL DESIGN

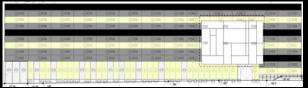
MECHANICAL

MECHANICAL NORTHWEST CURTAINWALL

CONSIDER REPLACING GLASS IN FRITTED PANELS WITH PPG SOLARBAN 70XL, THERMAL PROPERTIES SHOWN BELOW

MATERIAL	U-VALUE (BTU/HR-FT2-DEG F)	SHADING COEFFICIENT
OPAQUE PANEL (BLACK)	0.1	N/A
TRANSLUCENT PANEL (GREY)	0.25	0.2
FRITTED PANEL (YELLOW)	0.32	0.47
ppg solarban 70XL	0.27	0.32

EXISTING NORTHWEST CURTAINWALL



PROPOSED NORTHWEST CURTAINWALL



NORTHWEST CURTAINWALL SYSTEM SOUTHWEST CURTAINWALL SYSTEM ATRIUM SKYLIGHT SUMMARY LOADS

MECHANICAL LOADS

OUTLINE

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ELECTRICAL DESIGN

MECHANICAL LOAD

MECHANICAL SOUTHWEST CURTAINWAL

OBJECTIVES

IMPROVE QUALITY OF DAYLIGHT DELIVERY SYSTEM BY REPLACING
 2 OPAQUE SPANDREL PANELS WITH FRITTED PANELS

2. MINIMIZE THE THERMAL IMPACT OF CURTAINWALL MODIFICATIONS

PANEL THERMAL PROPERTIES

MATERIAL	U-VALUE (BTU/HR-FT2-DEG F)	SHADING COEFFICIENT
OPAQUE PANEL (GREEN)	0.1	N/A
FRITTED PANEL (BLUE)	0.32	0.47

EXISTING SOUTHWEST CURTAINWALL AT GRAD BPI

	F06 2	2 F06
3 FS1	EV1 3	(3)FV1
	F04 2	(2)F04

PROPOSED SOUTHWEST CURTAINWALL AT GRAD BPI

	EV13	(3)EV1
3 F51	EVI 3	(3 FV1
	F04(2)	2 F04

NORTHWEST CURTAINWALL SYSTEM SOUTHWEST CURTAINWALL SYSTEM ATRIUM SKYLIGHT SUMMARY LOADS

MECHANICAL LOADS

OUTLINE

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ELECTRICAL DESIGN

MECHANICAL LOADS

MECHANICAL SOUTHWEST CURTAINWALL

TRANSPARENT GLASS MATERIAL FOR FRITTED PANEL

CONSIDER REPLACING GLASS IN FRITTED PANELS WITH PPG SOLARBAI 70 XL, THERMAL PROPERTIES SHOWN BELOW

MATERIAL	U-VALUE (BTU/HR-FT2-DEG F)	SHADING COEFFICIENT
OPAQUE PANEL (GREEN)	0.1	N/A
FRITTED PANEL (BLUE)	0.32	0.47
ppg solarban 70XL	0.27	0.32

EXISTING SOUTHWEST CURTAINWALL AT GRAD BPI

	F06 2	2 F06
3 FS1	EV1 3	(3)FV1
	F04 2	(2)F04

PROPOSED SOUTHWEST CURTAINWALL AT GRAD BPI

	FV13	(3)EV1
3 F51	EVI 3	(3 FVT)
	F04 2	2 F04

DESIGN ATRIUM SKYLIGHT SUMMARY LOADS

MECHANICAL LOADS

OUTLINE

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ELECTRICAL DESIGN

MECHANICAL LOAD

MECHANICAL ATRIUM SK

OBJECTIVES

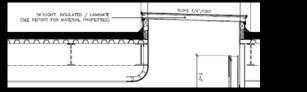
I. IMPROVE QUALITY OF DAYLIGHT DELIVERY SYSTEM BY NEARLY DOUBLING SKYLIGHT WIDTH IN ATRIUM

2. DETERMINE THE THERMAL IMPACT OF THIS RESIZING

SKYLIGHT WIDTH INCREASED FROM 6'-4" TO II'-6"

MATERIAL	U-VALUE (BTU/HR-FT2-DEG F)	SHADING COEFFICIENT
ROOF	0.042	N/A
SKYLIGHT-LAMINATED VISION	0.34	0.65

ORIGINAL SKYLIGHT



RESIZED SKYLIGHT

SKULPHT: INSULATED / LANINATE (SEE REPORT FOR WATERIAL PROPERTIES)	W ISAN	SLOPE 1/4*/rogr	
	Y	t in the second s	
10		4-0°	

NORTHWEST CURTAINWALL SYSTEM SOUTHWEST CURTAINWALL SYSTEM ATRIUM SKYLIGHT SUMMARY LOADS

MECHANICAL LOADS

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ELECTRICAL DESIGN

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MECHANICAL LOADS

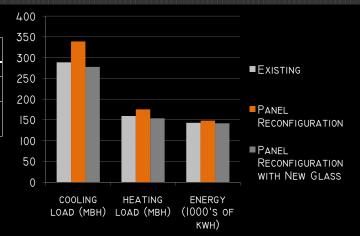
ELECTRICAL DESIGN

CONCLUSION

TOTAL COOLING/HEATING LOADS AND ENERGY

ALTERNATIVE	COOLING LOAD (MBH)				ENERGY (KWH)		STEAM (THERMS)	
EXISTING	288.7	-	159.3	-	142,985	-	813	-
PANEL/SKYLIGHT RECONFIGURATION	339	17.4%	175.3	10.0%	148,119	3.6%	1,281	57.6%
PANEL/SKYLIGHT RECONFIGURATION WITH NEW GLASS	277.6	-3.8%	153.8	-3.5%	141,818	-0.8%	661	-18.7%

*NOTE: NEW PPG GLASS TYPE IS ONLY APPLIED TO CURTAINWALL



MECHANICAL

MECHANICAL SUMMARY L

TOTAL COMBINED THERMAL AND DAYLIGHT SAVINGS

NORTHWEST CURTAINWALL SYSTE SOUTHWEST CURTAINWALL SYSTE ATRIUM SKYLIGHT SUMMARY LOADS

MECHANICAL LOADS

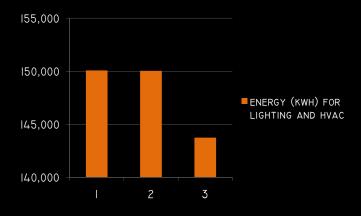
OUTLINE

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ELECTRICAL DESIGN

DESIGN	BASE LOAD (KWH)	PERCENT SAVINGS
(I) EXISTING CONDITION	150,065	_
(2) NEW PANEL CONFIGURATION AND DAYLIGHT CONTROLS	150,028	0.02%
(3) NEW PANEL CONFIGURATION, PPG GLASS, AND DAYLIGHT CONTROLS	143,727	4.22%



OUTLINE	ELECTRICAL DESIGN	ELECTRICAL COPPER VS. ALUMINUM FEEDERS
INTRODUCTION	FEEDER RESIZING AND COPPER VS. ALUMINUM	OBJECTIVES I. CONSIDER THE PERFORMANCE RELATED IMPACT OF CHANGING THE ELECTRICAL FEEDERS FROM COPPER TO ALUMINUM 2. CONSIDER THE ECONOMIC IMPACT OF RESIZING THE ELECTRICAL FEEDERS TO MEET NEC REQUIREMENTS
DAYLIGHTING		3. CONSIDER THE ECONOMIC IMPACT OF CHANGING THE ELECTRICAL FEEDERS FROM COPPER TO ALUMINUM
MECHANICAL LOADS		CURRENT VERSUS PROPOSED MATERIALS
ELECTRICAL DESIGN		CURRENT SYSTEM IS STRANDED COPPER THHN CONDUCTORS IN EMT PROPOSED SYSTEM IS STRANDED ALUMINUM THHN CONDUCTORS IN EMT
CUNCLUSION		

OUTLINE	ELECTRICAL DESIGN	ELECTRICAL COPPER VS. ALUMINUM FEEDERS
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		PERFORMANCE RELATED CONSIDERATIONS
INTRODUCTION	FEEDER RESIZING AND COPPER VS. ALUMINUM	+ CONVENTIONAL OPINIONS + HISTORICAL BACKGROUND
LIGHTING DESIGN		+ PRODUCT COST + MATERIAL WEIGHT
DAYLIGHTING		+ CONNECTIONS
MECHANICAL LOADS		+ ALUMINUM APPLICATIONS TODAY + NEWER ALUMINUM PRODUCTS
ELECTRICAL DESIGN		+ PROPER INSTALLATION
CONCLUSION		

	ELECTRICAL DESIGN	ELECTRICAL	COPPER	R VS. ALUMINUM	1 FEEDERS					
	FEEDER RESIZING AND COPPER VS. ALUMINUM	COMPARATIVE COSTS FOR EACH ALTERNATIVE *COSTS BASED ON RS MEANS 2010 DATA FOR CONDUCTOR AND CONDUIT PRICING, INCLUDING OVERHEAD AND PROFIT				\$50,000 \$48,000	\$48,000			
LIGHTING DESIGN		DESIGN	TOTAL COST	COST REDUCTION FROM EXISTING	PERCENT REDUCTION	\$46,000 - \$44,000 -				
DAYLIGHTING		EXISTING COPPER	\$47,675		-	\$42,000				
		RESIZED COPPER	\$43,410	\$4,265	8.95%	\$40,000				TOTAL COST
MECHANICAL LOADS		ALUMINUM	\$39,889	\$7,786	16.33%	\$38,000 -				
ELECTRICAL DESIGN		ALUMINUM FEEDERS ARE RECOMMENDED COST REDUCTION FROM NEC RESIZING ALSO NOTABLE				\$36,000 - \$34,000 -	EXISTING COPPER	NEC RESIZED COPPER	ALUMINUM	

OUTLINE	CONCLUSION	CONCLUSION	SUMMARY OUTCOME
Standard		LIGHTING DESIGN	DESIGNS EVOKE TRANSPARENCY, ENERGY, AND EXPANSION OF IDEAS
INTRODUCTION	SUMMARY OUTCOME	DAYLIGHTING	DESIGNS COMPLY WITH IESNA AND ASHRAE
	ACKNOWLEDGEMENTS		MODIFIED SKYLIGHT/CURTAINWALL IMPROVE QUALITY OF DAYLIGHTING
LIGHTING DESIGN DAYLIGHTING			DAYLIGHT CONTROL SYSTEMS ALLOW FOR 73% ENERGY SAVINGS
MECHANICAL LOADS		MECHANICAL LOADS	MODIFIED PANELS ALLOW FOR REDUCED THERMAL LOADS
NECHANICAL LUADS			5% COMBINED LIGHTING/HVAC ENERGY ↓
ELECTRICAL DESIGN		ELECTRICAL DESIGN	16.33% COST SAVINGS WITH AL FEEDERS
		OVERALL	DESIGNS SUCCESSFULLY IMPROVE
CONCLUSION			AESTHETICS AND PERFORMANCE

OUTLINE	CONCLUSION	CONCLUSION	SPECIAL THANKS		
S 4. 4. 5		PRINCETON UNIVERSITY	CATHERINE ALTADONNA MICHAEL DENCHAK	PENN STATE AE FACULTY	PROFESSOR MISTRICK PROFESSOR HOUSER
INTRODUCTION	SUMMARY OUTCOME ACKNOWLEDGEMENTS	COME FISHER MARANTZ STONE CHARLES STONE			PROFESSOR DANNERTH
LIGHTING DESIGN			ENRIQUE GARCIA HANK FORREST		PROFESSOR HOLLAND PROFESSOR PARFITT
DAYLIGHTING		FREDERICK FISHER AND PARTNERS		LUTRON SCHEMATIC	PROFESSOR TREATO LEE BRANDT
MECHANICAL LOADS		JOSEPH LORING ENGINEERS	NITISH JOY	DESIGN CRITICS	KARI NYSTROM LUKE TIGUE
ELECTRICAL DESIGN					SANDRA STASHIK HELEN DIEMER
CONCLUSION				AND TO MY FAMIL	Y, FRIENDS, AND FELLOW AE

QUESTION AND ANSWER SESSION



"LIGHT is a central theme throughout the building. It's a kind of lantern, a lantern of knowledge and circulation." Frederick fisher