



BUILDING BACKGROUND

ARCHITECTURE BREADTH

- South Terrace Redesign

LIGHTING DEPTH

- South Terrace
- Typical Large Classroom
- Three Alternate Designs
- Atrium
- Blue Chip Bistro Café

ELECTRICAL DEPTH

- Copper vs. Aluminum Feeder Comparison
- Distribution Panel Redesign
- Lighting Branch Circuit Redesign
- Short Circuit Study

ACOUSTICS BREADTH


- Café Ceiling Design Study

OVERVIEW

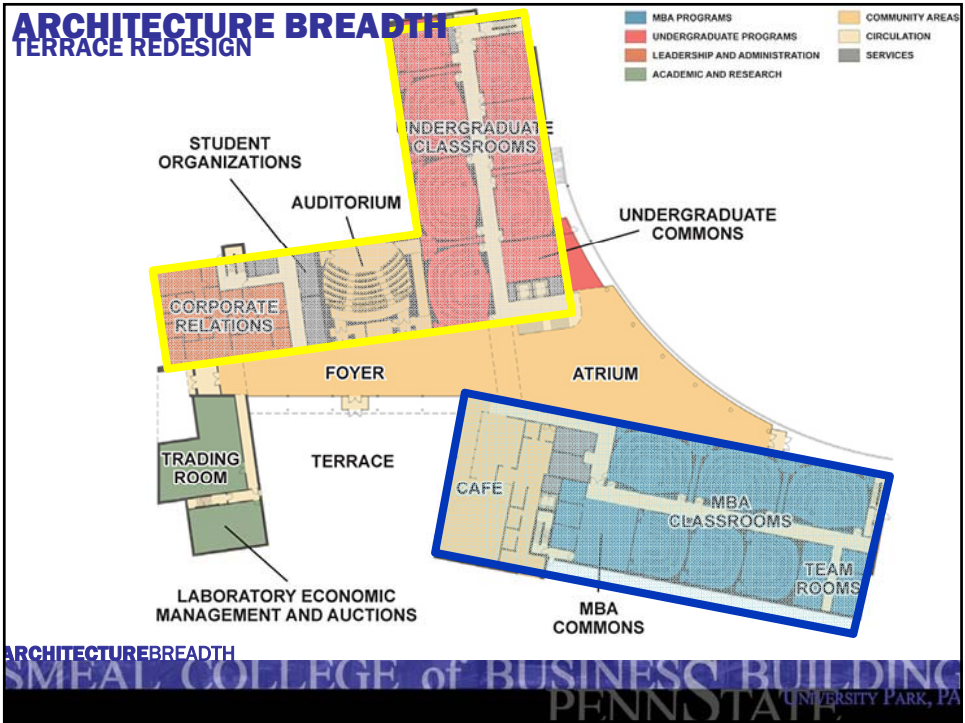
SMEAL COLLEGE OF BUSINESS BUILDING
UNIVERSITY PARK, PA
PENNSTATE

ARCHITECTS Bower Lewis Throter Architects (Philadelphia, PA)
ASSOCIATE ARCHITECTS Robert A. M. Stern Architects (New York, NY)
MEP ENGINEERS Bard, Rao + Athanas Consulting Engineers (Boston, MA)
CONSTRUCTION MANAGER Gilbane (State College, PA)

PROJECT COST \$68,000,000
SCOPE 210,000 SF
LEVELS Four above grade, one below grade
CONSTRUCTION SCHEDULE July 2003 - July 2005
DEDICATION DATE September 30, 2005



BUILDING BACKGROUND
SMEAL COLLEGE of BUSINESS BUILDING
PENNSYLVANIA STATE UNIVERSITY PARK, PA



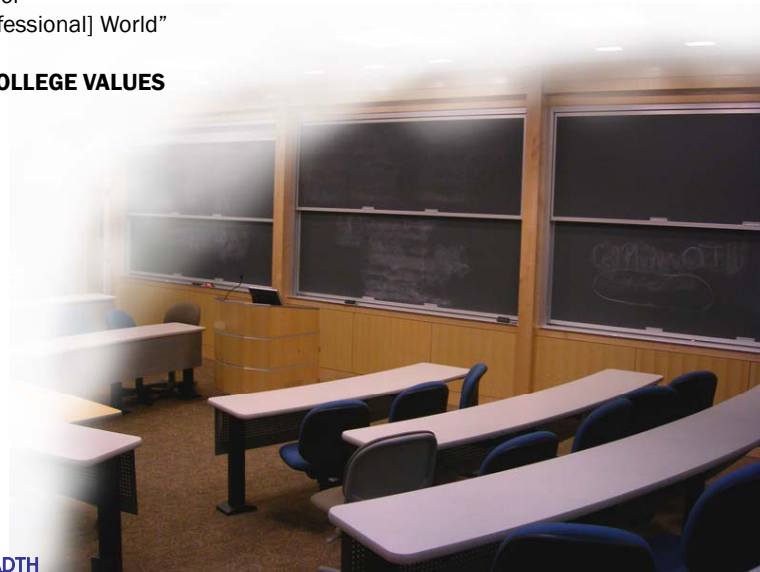


EDUCATIONAL FACILITY

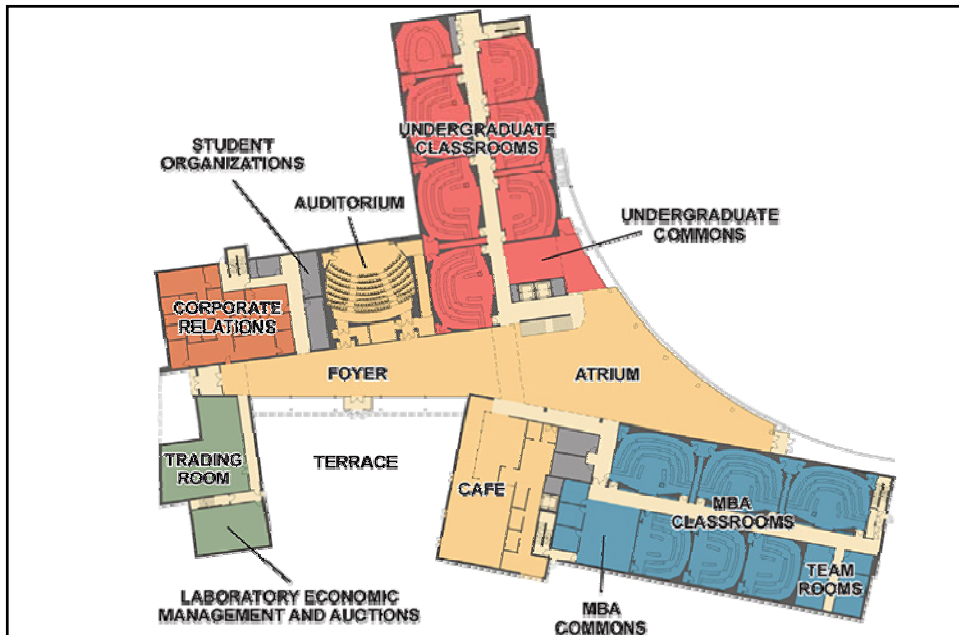
Business School
The "Real [Professional] World"

THE SMEAL COLLEGE VALUES

Openness
Transparency
Community



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LIGHTING DEPTH
TERRACE

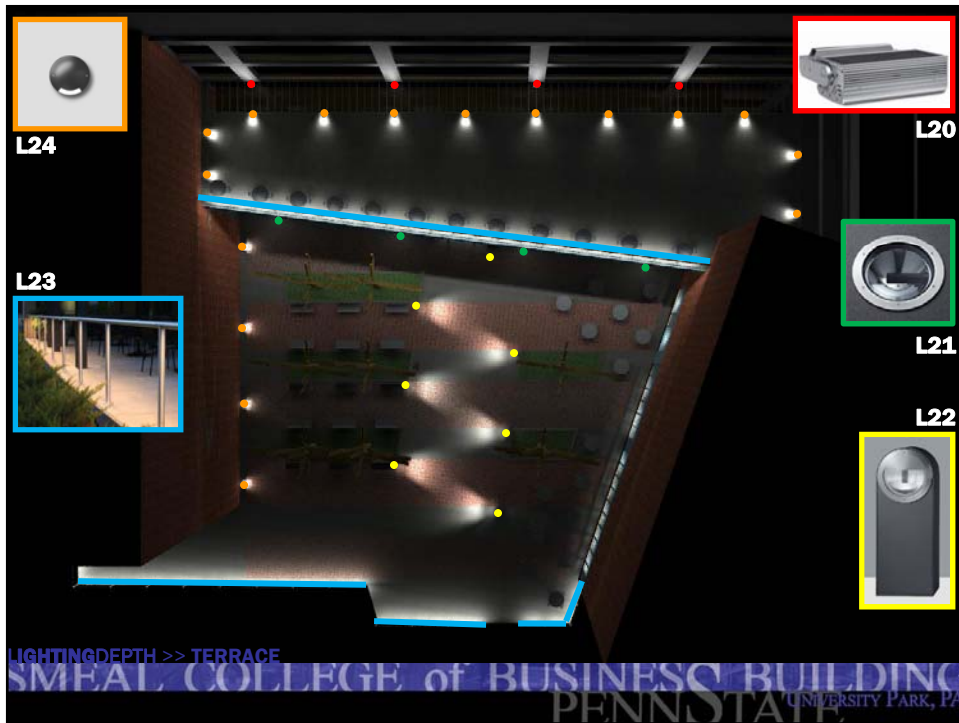
OVERVIEW

- Serves as main entrance from campus, a gathering space, café outdoor seating
- Trapezoidal, bi-level (ground and third floors), ~14,260 SF
- Brick, limestone, aluminum and glass curtain walls
- Benches, café seating furniture, planting beds, bronze sculpture

DESIGN GOALS

- Link to architecture and rest of campus
- Highlight circulation paths and entrance
- 1 fc average (0.1 fc minimum) along circulation paths

LIGHTINGDEPTH >> TERRACE



LIGHTINGDEPTH >> TERRACE



ASHRAE 90.1-2004 Power Density Requirements

Table 9.4.5: Building Grounds: Walkways 10 ft wide or greater/Plaza areas

- Building Grounds = 0.20 W/SF

Table 9.4.5: Lighting Power Densities for Building Exteriors

- Canopies = 1.25 W/SF

- Building Façades = 5.00 W/LF

Total Power Allowed per Design Space:

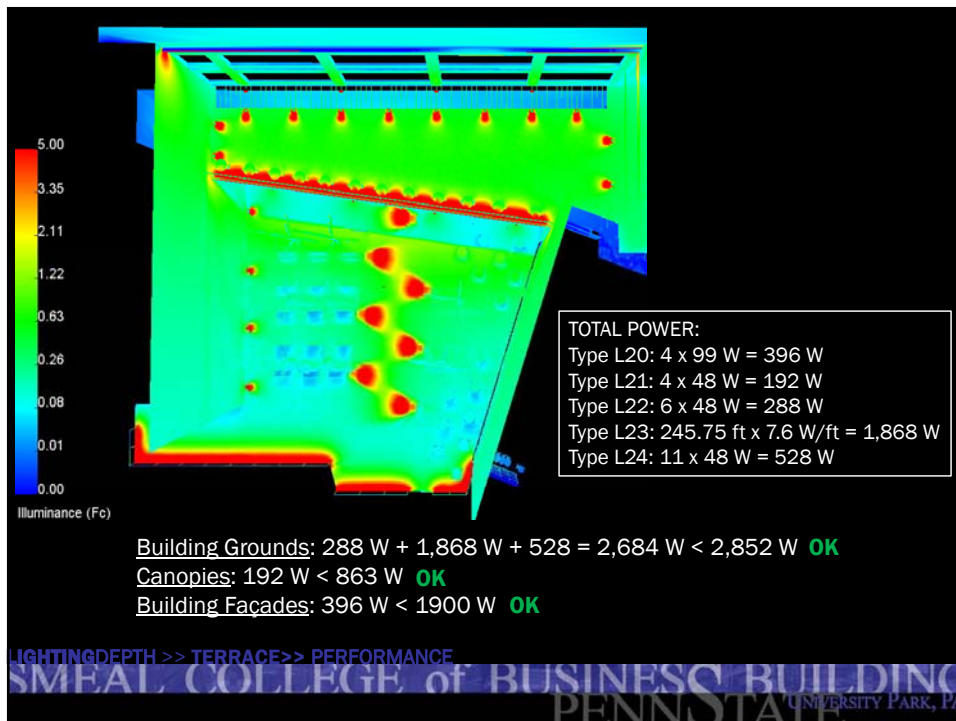
- Building Grounds: 0.20 W/SF x 14,260 SF = **2,852 W**

- Canopies: 1.25 W/SF x 690 SF = **862.5 W**

- Building Façades: 5.00 W/LF x 380 LF = **1,900 W**

LIGHTINGDEPTH >> TERRACE

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LIGHTING DEPTH

THREE ALTERNATE DESIGNS: CLASSROOM

OVERVIEW

- 44'x30' (1,330 SF), 60 student capacity
- Dark carpeting, ACT ceiling, curved perforated acoustical wood paneling
- Tiered, semi-circular seating arrangement with two aisles

DESIGN GOALS

- 60 fc at desk per PSU classroom lighting standard
- Conducive to learning
 - minimize visual clutter to minimize distractions
 - flexible controls to adapt to various needs

THREE ALTERNATE DESIGNS

- Option 1: recessed linear striplights in system-organizing ceiling system
- Option 2: recessed 2'x2' lensed direct/indirect troffers
- Option 3: direct/indirect linear pendants

LIGHTINGDEPTH>> CLASSROOM

ASHRAE 90.1-2004 Power Density Requirements

Table 9.5.1: Lighting Power Densities Using the Space-by-Space Method

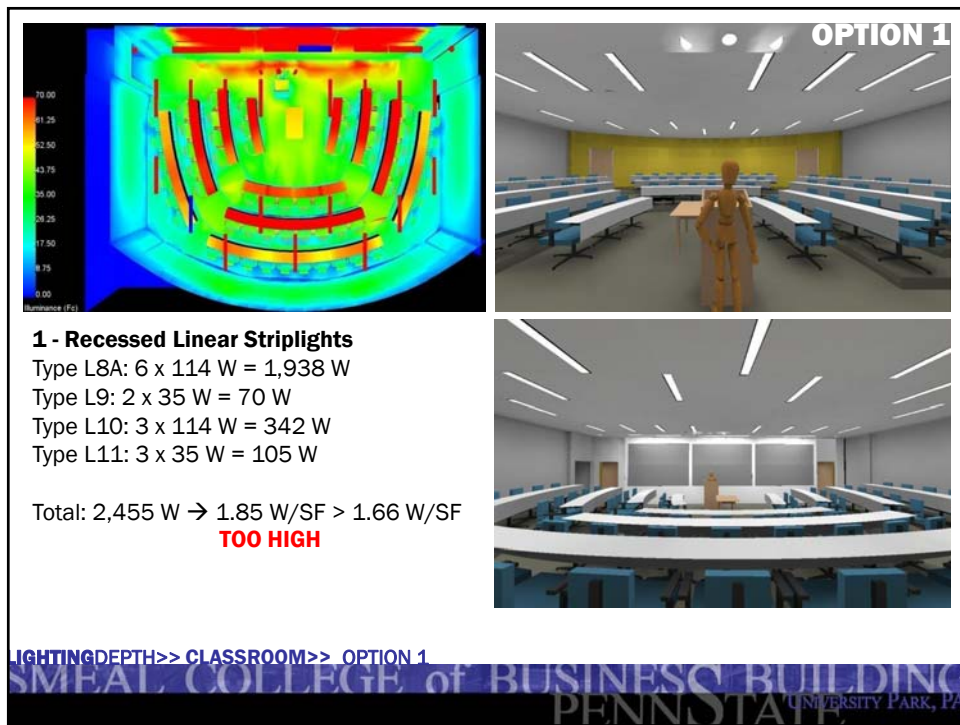
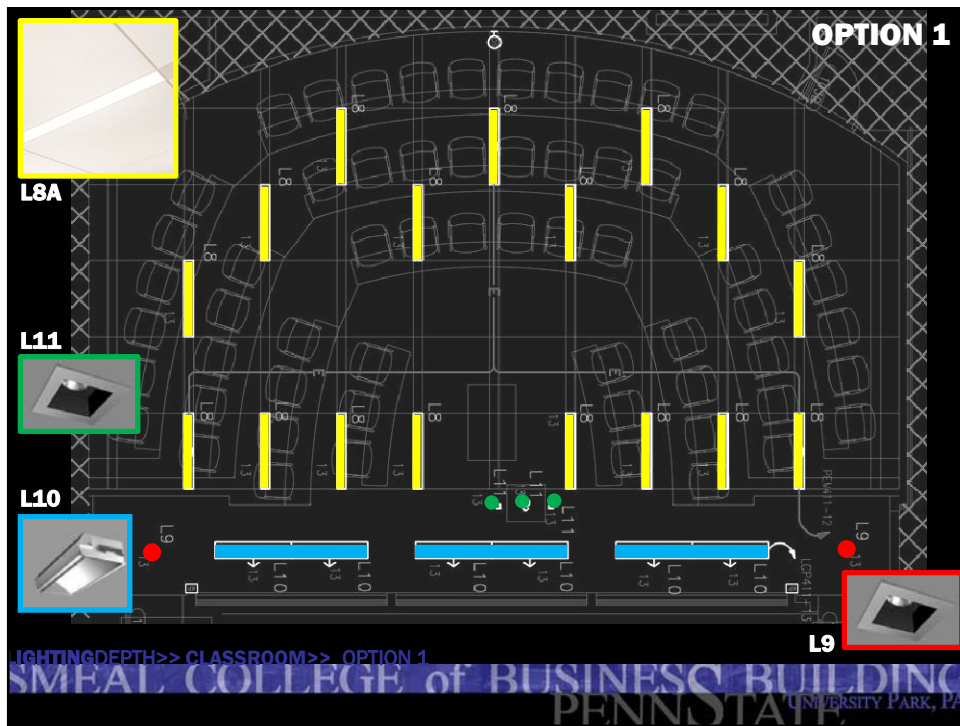
- Classroom/Lecture/Training = 1.40 W/SF

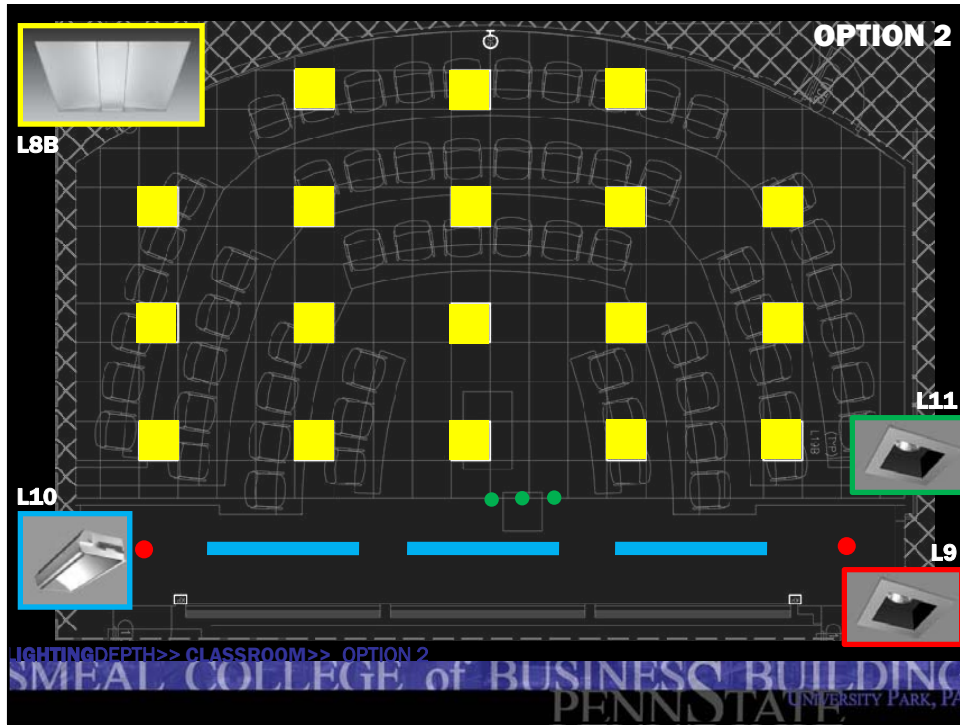
Additional Allowances Per Article 9.6.3(a)

- Wall-washers (type L10): 3 fixtures x 114 W/fixture = 342 W
 $342 \text{ W} / 1,330 \text{ SF} = 0.26 \text{ W/SF}$

Total LPD: $1.40 \text{ W/SF} + 0.26 \text{ W/SF} = 1.66 \text{ W/SF}$

LIGHTINGDEPTH>> CLASSROOM



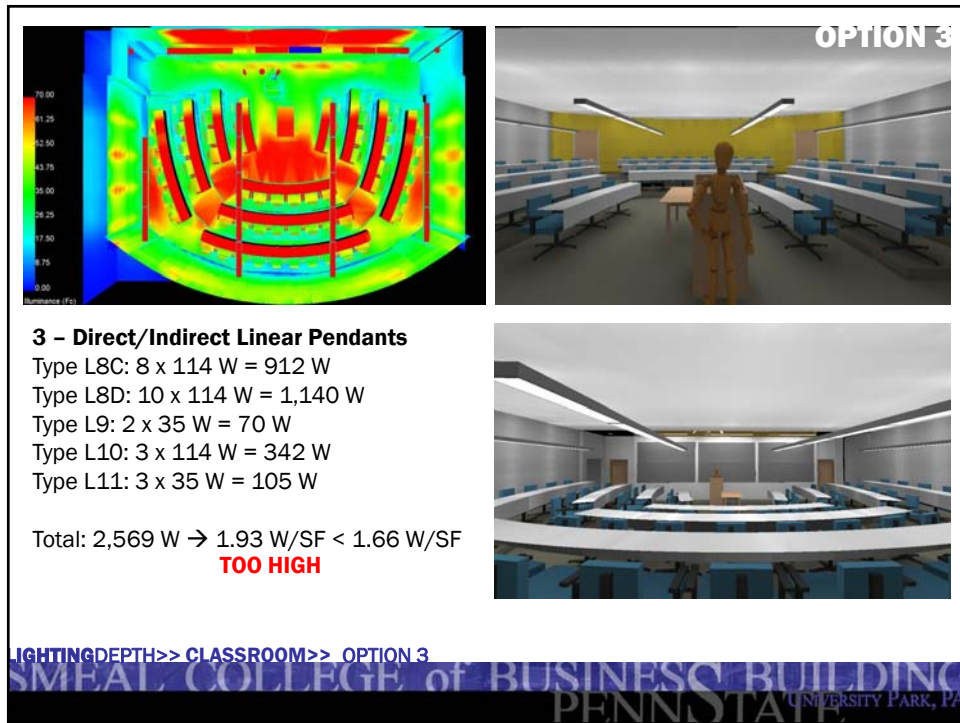
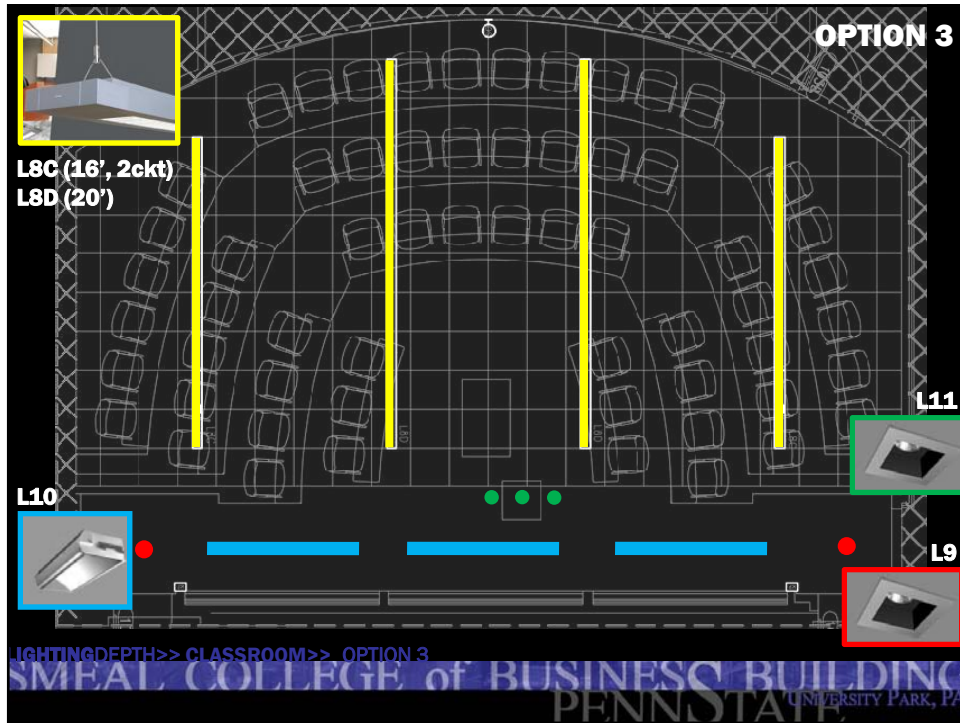


2 - Recessed Lensed Troffers
 Type L8B: 18 x 70 W = 1,260 W
 Type L9: 2 x 35 W = 70 W
 Type L10: 3 x 114 W = 342 W
 Type L11: 3 x 35 W = 105 W

Total: 1,777 W → 1.34 W/SF < 1.66 W/SF
OK

LIGHTINGDEPTH>> CLASSROOM>> OPTION 2

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**ELECTRICAL DEPTH
COPPER vs ALUMINUM FEEDER COMPARISON**

COMPARISON STUDY BASIS

Feeder samples taken from loads directly serviced by main switchboard 'MS4L'

- Largest loads → largest feeder sizes → most expensive
- Longest runs (lower level to penthouse level)

Copper's ampacity equivalent aluminum sizes determined via NEC Table 310-16.

METAL CHARACTERISTICS

COPPER

- 1.6 times the ampacity of aluminum
- smaller sizes → more flexible
- less bulk → easier transport
- harder and stronger
 - withstands nicks and other mechanical abuse better
- corrosion resistant

ALUMINUM

- cheaper than copper
- softer; lower modulus of elasticity
- higher thermal expansion coefficient
(13.1 micro in/in °F vs 9.8 micro in/in °F)
 - can loosen joints and connections from frequent expansion/contraction movements
- corrodes easily with moisture

ELECTRICAL DEPTH >> FEEDER COMPARISON



COPPER PRICING												
TAG	FROM	TO	LENGTH [FT]	NO. OF SETS	CONDUCTORS (PER SET)						OCP	TOTAL
					PHASE/NEUTRAL			GROUND				
					No.	SIZE	\$/LF	No.	SIZE	\$/LF		
18	MS4L	ATS-EM	50	1	4	250KCMIL	28.67	1	4AWG	2.12	250	\$ 1,539.17
20	MS4L	DP4L2	50	1	4	350KCMIL	37.33	1	4AWG	2.12	300	\$ 1,972.50
20	MS4L	DP4L3	45	1	4	350KCMIL	37.33	1	4AWG	2.12	300	\$ 1,775.25
24	MS4L	ATS-LR	70	1	4	600KCMIL	47.00	1	3AWG	2.29	400	\$ 3,450.30
26	MS4L	DP4P2	250	2	4	250KCMIL	28.67	1	2AWG	2.72	500	\$15,691.67
28	MS4L	DP4L1	40	2	4	350KCMIL	37.33	1	1AWG	3.90	600	\$ 3,298.67
30	MS4L	DP4P1	260	2	4	600KCMIL	28.67	1	1/0AWG	4.08	800	\$17,030.00
T7P	MS4L	T7	30	1	3	350KCMIL	28.00	1	4AWG	2.12	800	\$ 903.50
T7S	T7	DP2L	15	2	4	250KCMIL	28.67	1	2AWG	2.72	800	\$ 941.50
TOTAL											\$46,602.55	

ELECTRICAL DEPTH >> FEEDER COMPARISON



ALUMINUM PRICING												
TAG	FROM	TO	LENGTH [FT]	NO. OF SETS	CONDUCTORS (PER SET)						OCP	TOTAL
					PHASE/NEUTRAL			GROUND				
					No.	SIZE	\$/LF	No.	SIZE	\$/LF		
18	MS4L	ATS-EM	50	1	4	350KCMIL	18.53	1	3AWG	1.63	250	\$ 1,008.17
20	MS4L	DP4L2	50	1	4	500KCMIL	22.27	1	3AWG	1.63	300	\$ 1,194.83
20	MS4L	DP4L3	45	1	4	500KCMIL	22.27	1	3AWG	1.63	300	\$ 1,075.35
24	MS4L	ATS-LR	70	2	4	350KCMIL	18.53	1	2AWG	1.77	400	\$ 2,842.00
26	MS4L	DP4P2	250	2	4	350KCMIL	18.53	1	1AWG	1.98	500	\$10,258.33
28	MS4L	DP4L1	40	3	4	250KCMIL	16.80	1	1/0AWG	2.42	600	\$ 2,306.00
30	MS4L	DP4P1	260	3	4	500KCMIL	22.27	1	3/0AWG	3.05	800	\$19,747.00
T7P	MS4L	T7	30	1	3	500KCMIL	16.70	1	3AWG	1.63	800	\$ 549.90
T7S	T7	DP2L	15	2	4	500KCMIL	22.27	1	1AWG	1.98	800	\$ 727.50
TOTAL											\$39,709.08	

ELECTRICAL DEPTH >> FEEDER COMPARISON

SMEAL COLLEGE of BUSINESS BUILDING
UNIVERSITY PARK, PA
PENNSTATE**PRICE COMPARISON**

- Copper: \$46,602.55

- Aluminum: \$39,709.08 → **\$6,893.47 savings, (14.8%)**

Aluminum has the potential to provide a significantly cheaper initial material cost, but may also create greater future maintenance costs in long term projects due to its shorter lifespan.

BOTTOM LINEUse of **copper** feeders is recommended for the Smeal Business Building.

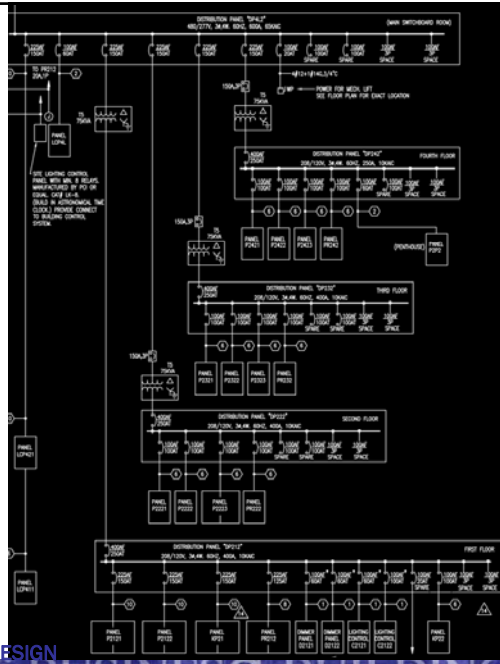
ELECTRICAL DEPTH >> FEEDER COMPARISON

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UNIVERSITY PARK, PA
PENNSTATE

ELECTRICAL DEPTH DISTRIBUTION PANEL REDESIGN

DESIGN BASIS & ASSUMPTIONS

- Panel 'LCP421' replaced with 'LCP411'
- 208/120V distribution panels fed through 75 kVA transformers
 - transformer rating loaded at 80%
 - power factor=0.8
- Associated feeder used to assume a load for the mechanical lift
- Spare circuits loaded at 65% capacity
 - power factor=1
 - demand factor=1



ELECTRICAL DEPTH >> DISTRIBUTION PANEL REDESIGN
 SMEAL COLLEGE of BUSINESS BUILDING
 PENN STATE UNIVERSITY PARK, PA

LIGHTING AND APPLIANCE PANELBOARD SIZING WORKSHEET

Panel Tag	DP412	Panel Location	Rm #P103
Nominal Phase to Neutral Voltage	277	Phase	3
Nominal Phase to Phase Voltage	480	Wires	4

Pos	Ph	Load Type	Cat	Location	Load	Units	PF	Watts	VA	Remarks
1	A	Ltg Panel	3	1st fl	21600	VA	0.95	20520	21600	LCP411 (A)
2	A	Ltg Panel	3	lower level	8500	VA	0.95	8075	8500	LCP41 (A)
3	B	-	3	-	18500	VA	0.95	17575	18500	LCP411 (B)
4	B	-	3	-	5800	VA	0.95	5510	5800	LCP41 (B)
5	C	-	3	-	22000	VA	0.95	20900	22000	LCP411 (C)
6	C	-	3	-	2800	VA	0.95	2660	2800	LCP41 (C)
7	A	75 kVA xfmr	1	1st fl	20000	VA	0.80	16000	20000	DP212 (A)
8	A	75 kVA xfmr	1	2nd fl	20000	VA	0.80	16000	20000	DP222 (A)
9	B	-	1	-	20000	VA	0.80	16000	20000	DP212 (B)
10	B	-	1	-	20000	VA	0.80	16000	20000	DP222 (B)
11	C	-	1	-	20000	VA	0.80	16000	20000	DP212 (C)
12	C	-	1	-	20000	VA	0.80	16000	20000	DP222 (C)
13	A	75 kVA xfmr	1	3rd fl	20000	VA	0.80	16000	20000	DP232 (A)
14	A	75 kVA xfmr	1	4th fl	20000	VA	0.80	16000	20000	DP242 (A)
15	B	-	1	-	20000	VA	0.80	16000	20000	DP232 (B)
16	B	-	1	-	20000	VA	0.80	16000	20000	DP242 (B)
17	C	-	1	-	20000	VA	0.80	16000	20000	DP232 (C)
18	C	-	1	-	20000	VA	0.80	16000	20000	DP242 (C)
19	A	Mech Lift	6	-	1477.333	VA	0.80	1182	1477	
20	A	SPARE	8	-	18005	w	1.00	18005	18005	Updated
21	B	-	6	-	1477.333	VA	0.80	1182	1477	
22	B	SPARE	8	-	18005	w	1.00	18005	18005	Updated
23	C	-	6	-	1477.333	VA	0.80	1182	1477	
24	C	SPARE	8	-	18005	w	1.00	18005	18005	Updated
25	A	SPACE	-	-	-	w	-	0	0	
26	A	SPACE	-	-	-	w	-	0	0	
27	B	-	-	-	-	w	-	0	0	
28	B	-	-	-	-	w	-	0	0	
29	C	-	-	-	-	w	-	0	0	
30	C	-	-	-	-	w	-	0	0	

PANEL TOTAL				324.8	377.6	Amps=	454.4
PHASE LOADING							
PHASE TOTAL	A			kW	kVA	%	Amps
PHASE TOTAL	B			111.8	129.8	34%	457.8
PHASE TOTAL	C			106.3	123.8	33%	446.9
PHASE TOTAL	C			106.7	124.3	33%	448.7
LOAD CATEGORIES							
				Connected	Demand		
				kW	kVA	PF	Watts
1	receptacles			192.0	240.0	0.80	192.0
2	computers			0.0	0.0	0.00	0.0
3	fluorescent lighting			75.2	79.2	0.95	75.2
4	LED lighting			0.0	0.0	0.00	0.0
5	incandescent lighting			0.0	0.0	0.00	0.0
6	HVAC fans			3.5	4.4	0.80	3.5
7	heatlans			0.0	0.0	0.00	0.0
8	Spare			54.0	54.0	1.00	54.0
Total Demand Loads				227.0	255.4		
Spare Capacity				45.4	51.1		
Total Design Loads				272.4	306.5	0.89	Amps= 368.0

400A / MLO
 400A breaker @'MS4L'
 4 -#600KCMIL+1#3G in 4" C

ELECTRICAL DEPTH >> DISTRIBUTION PANEL REDESIGN
 SMEAL COLLEGE of BUSINESS BUILDING
 PENN STATE UNIVERSITY PARK, PA

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V, 3PH, 4W SIZE/TYPE BUS: 400A SIZE/TYPE MAIN: MLO			PANEL TAG: DP4L2 PANEL LOCATION: Rm #P103 PANEL MOUNTING: SURFACE					MIN. C/B AIC: 65K OPTIONS:				
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltq Panel	1st fl	20520	100A/3P	1	*			2	60A/3P	8075	lower level	Ltq Panel
-	-	17575		3	*			4		5510	-	-
-	-	20900		5	*	*		6		2660	-	-
75 kVA xfmr	1st fl	16000	150A/3P	7	*			8	150A/3P	16000	2nd fl	75 kVA xfmr
-	-	16000		9	*			10		16000	-	-
-	-	16000		11	*	*		12		16000	-	-
75 kVA xfmr	3rd fl	16000	150A/3P	13	*			14	150A/3P	20000	4th fl	75 kVA xfmr
-	-	16000		15	*			16		20000	-	-
-	-	16000		17	*	*		18		20000	-	-
Mech'l Lift	-	1182	20A/3P	19	*			20	100A/1P	18005		SPARE
-	-	1182		21	*			22	100A/1P	18005		SPARE
-	-	1182		23	*	*		24	100A/1P	18005		SPARE
SPACE			3P	25	*			26	3P			SPACE
-				27	*			28				-
-				29	*	*		30				-
CONNECTED LOAD (KW) - A		111.78							TOTAL DESIGN LOAD (KW)		272.43	
CONNECTED LOAD (KW) - B		106.27							POWER FACTOR		0.89	
CONNECTED LOAD (KW) - C		106.75							TOTAL DESIGN LOAD (AMPS)		369	

ELECTRICAL DEPTH >> DISTRIBUTION PANEL REDESIGN

