The Virginia Commonwealth University
Life Sciences Building

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Architectural Engineering
Lighting/ Electrical Option

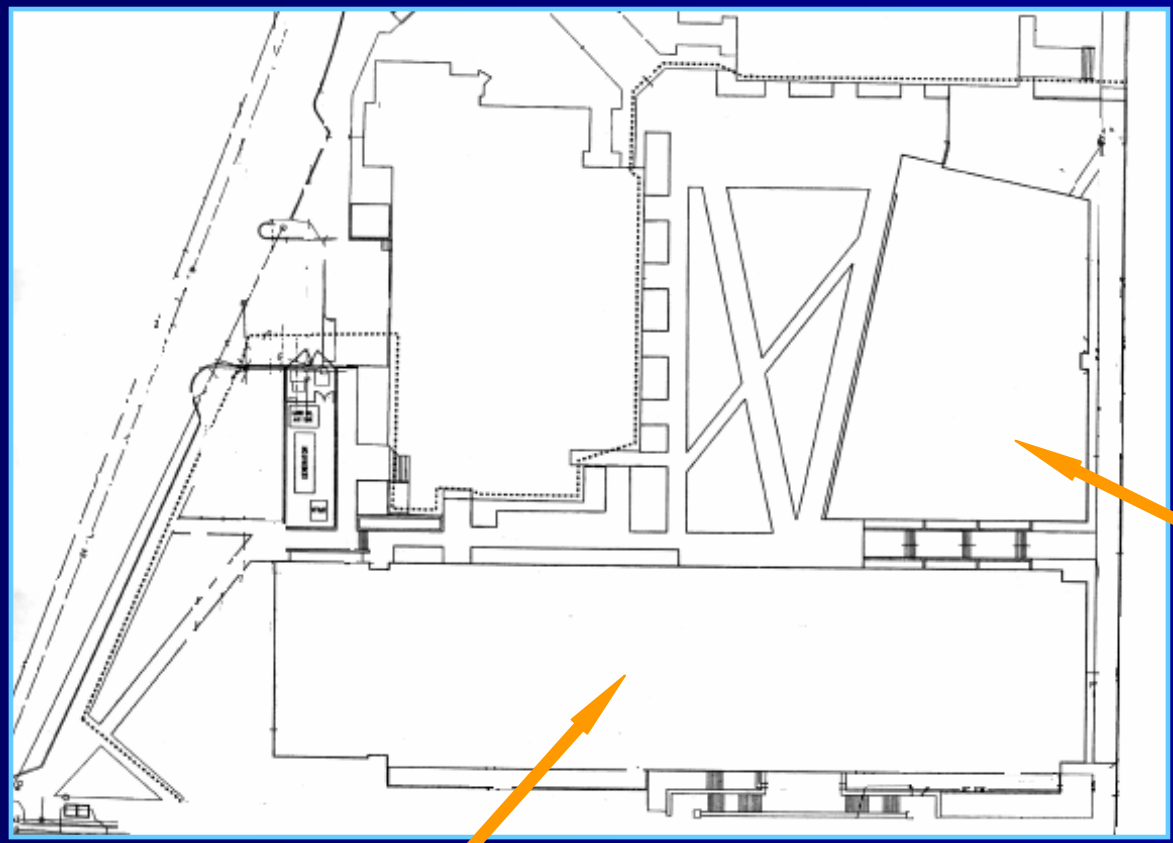
Presentation Outline

- *Building Overview*
- Lighting Depth
  - Lobby
  - Auditorium
- Electrical Depth
- Mechanical Breadth
- Conclusion
- Questions

Building Overview

- Location: Richmond, VA
- Size: 132,500 s.f.
- Owner: The Virginia Commonwealth University

Building Overview



Building Uses

- Classrooms
- Laboratories
- Auditoriums
- Greenhouse
- Aquatics Facility

Presentation Outline

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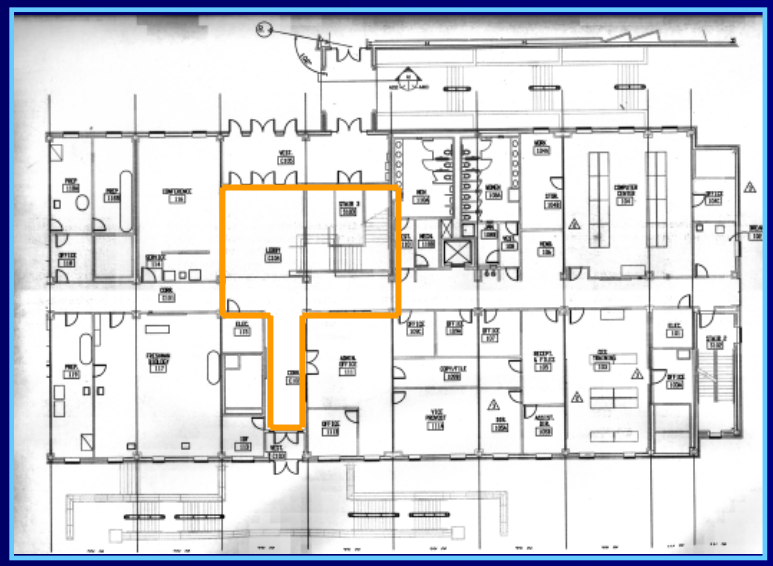
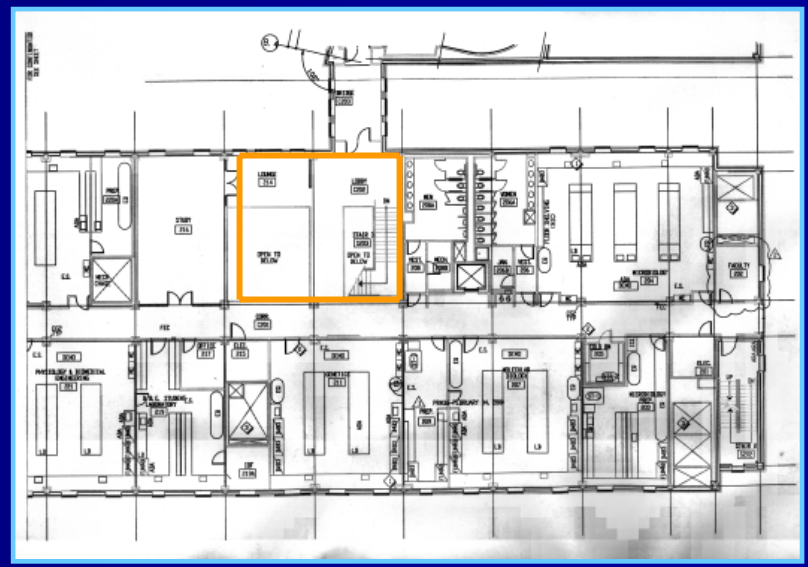
Lighting Depth- Lobby
Location

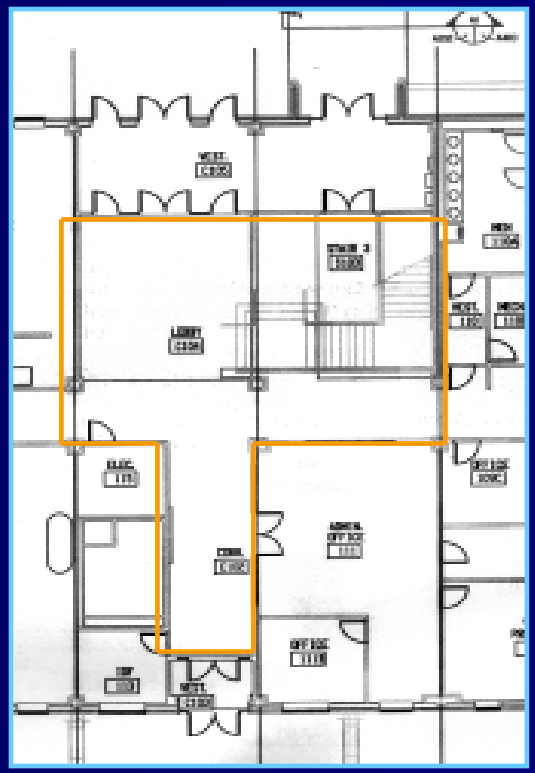


First Floor

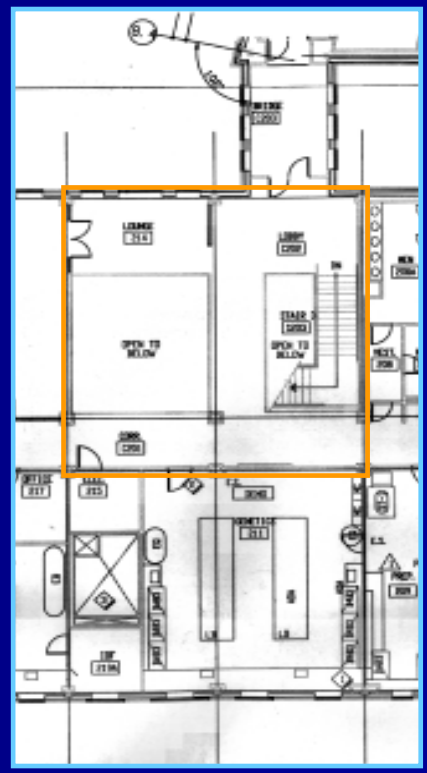


Second Floor

Lighting Depth- Lobby
Plan

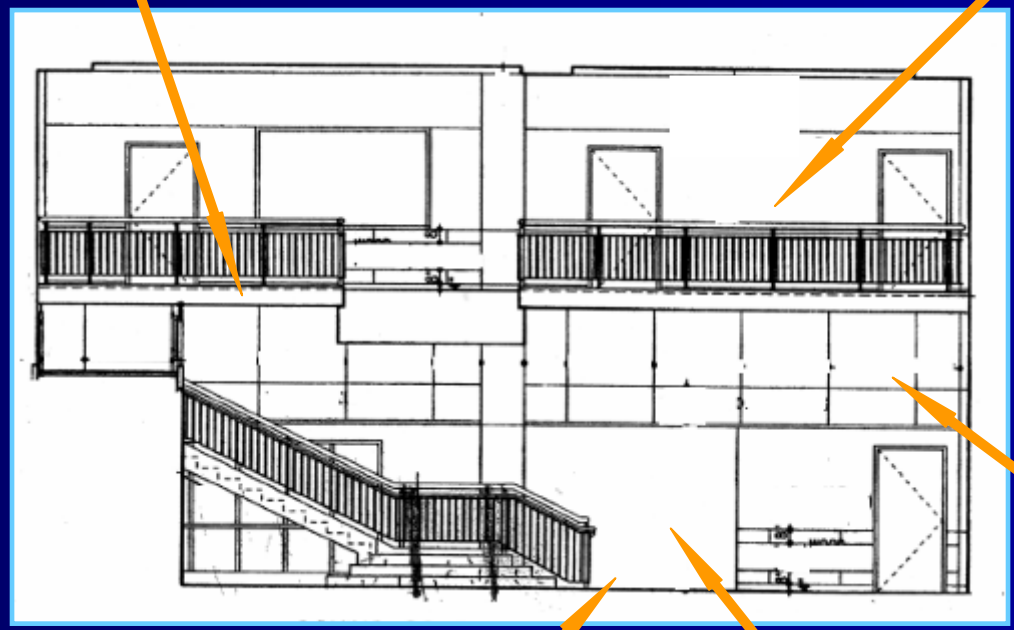


First Floor



Second Floor

Lighting Depth- Lobby
Elevation



Lighting Depth- Lobby

Design Considerations

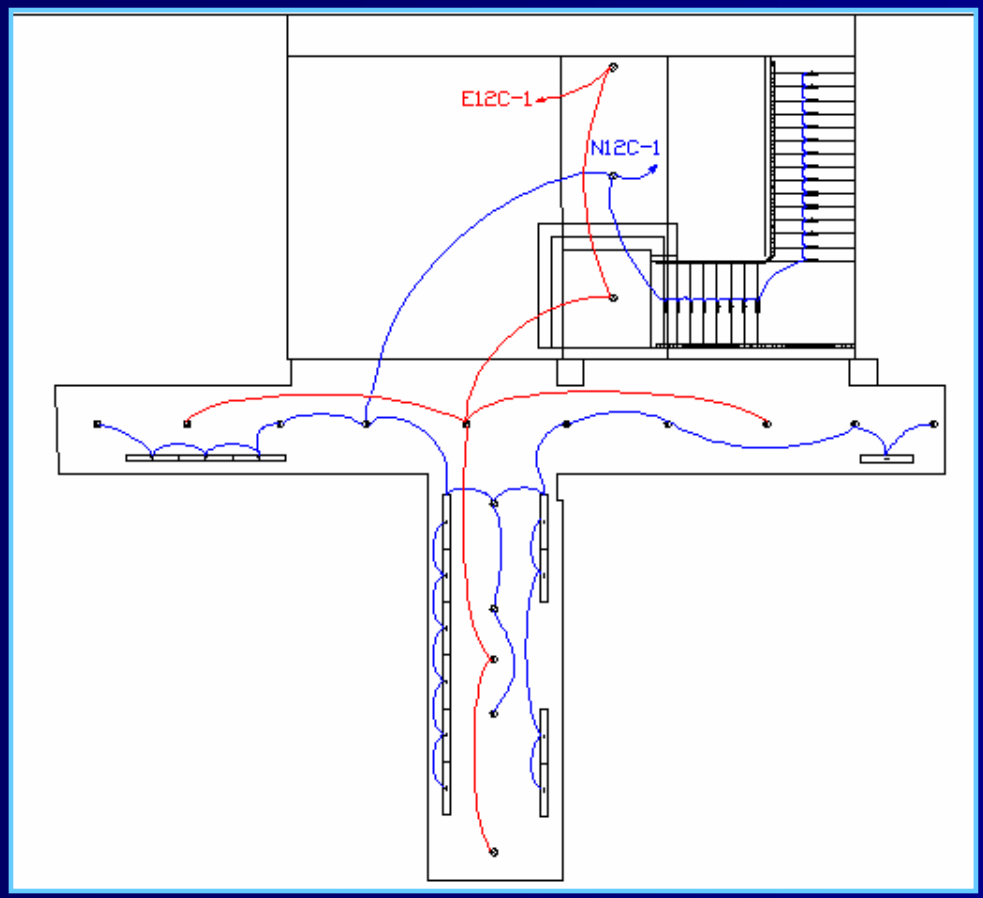
- Focal Points:
  - Stairway
  - Building Exits
  - Corridors
- Adjustment between outdoors and indoors

Lighting Depth- Lobby

Design Goals

- Highlight Wood Paneling
- Provide guidance in direction
- Inviting atmosphere
- Target Illuminance: 10 fc
- ASHRAE/ IESNA 90.1 Power Allowance: 1.3W/s.f.

Lighting Depth- Lobby
Layout



D1

(1) 13W CFL

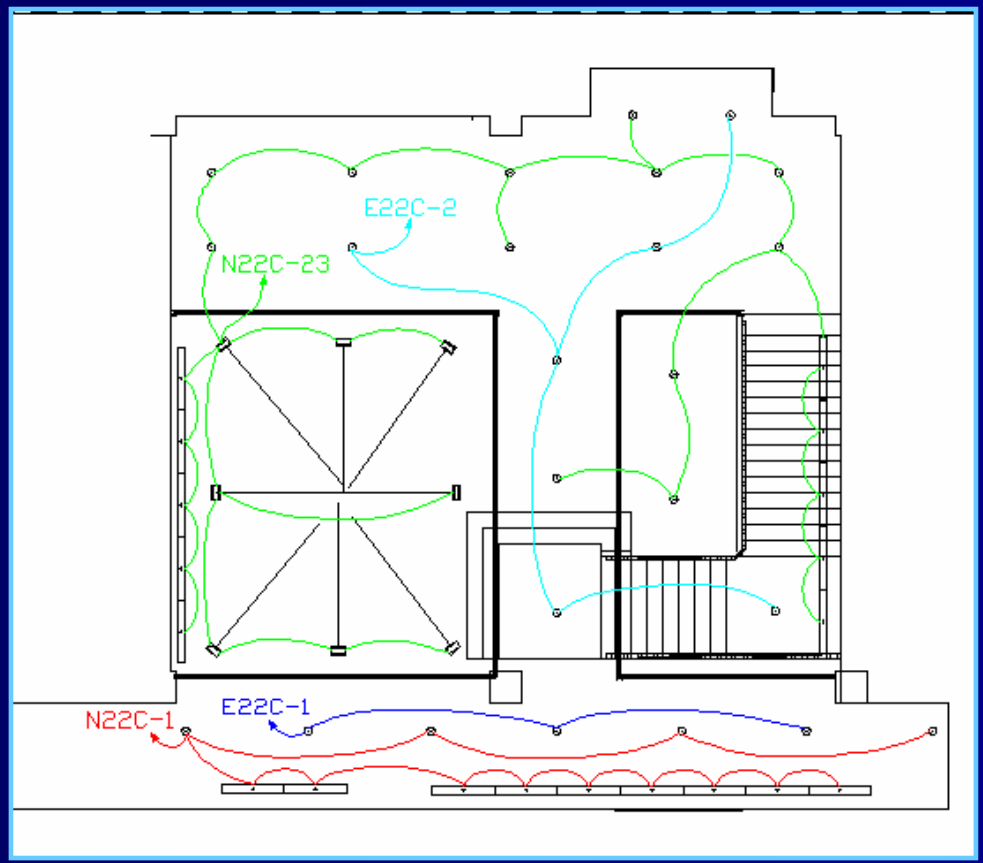
S1

(1) 13W CFL

WW2

(1) 32W T8

Lighting Depth- Lobby
Layout

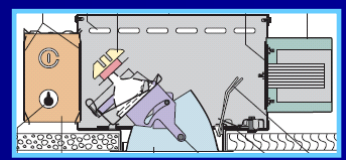


D1

(1) 13W CFL

S1

(1) 13W CFL



T1

(1) 50W MR16

WW2

(1) 32W T8

Lighting Depth- Lobby

Final Design Rendering

Lighting Depth- Lobby

Final Design Rendering

Lighting Depth- Lobby
Conclusions

Power Allowance:

ASHRAE/IESNA 90.1 1.3 W/s.f. OK

Luminaire	#	Ballast Watts	Total Watts
D1	46	13	598
S1	23	13	299
T1	8	50	400
WW2	33	30	990
		TOTAL WATTS	2287
		AREA (ft2)	2660
		POWER DENSITY (W/ft2)	0.86

Target Illuminance Values:

First Floor: 10fc

Second Floor: 10fc

Design Illuminance Values:

First Floor: 10fc OK

Second Floor: 10fc. OK

- Highlight wood paneling OK
- Provide guidance in direction OK
- Inviting atmosphere OK

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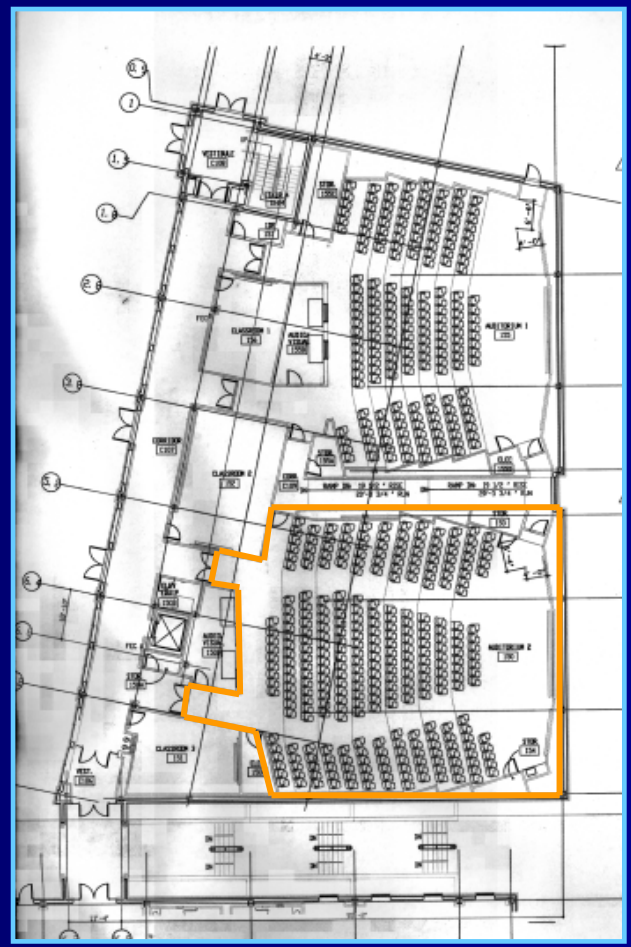
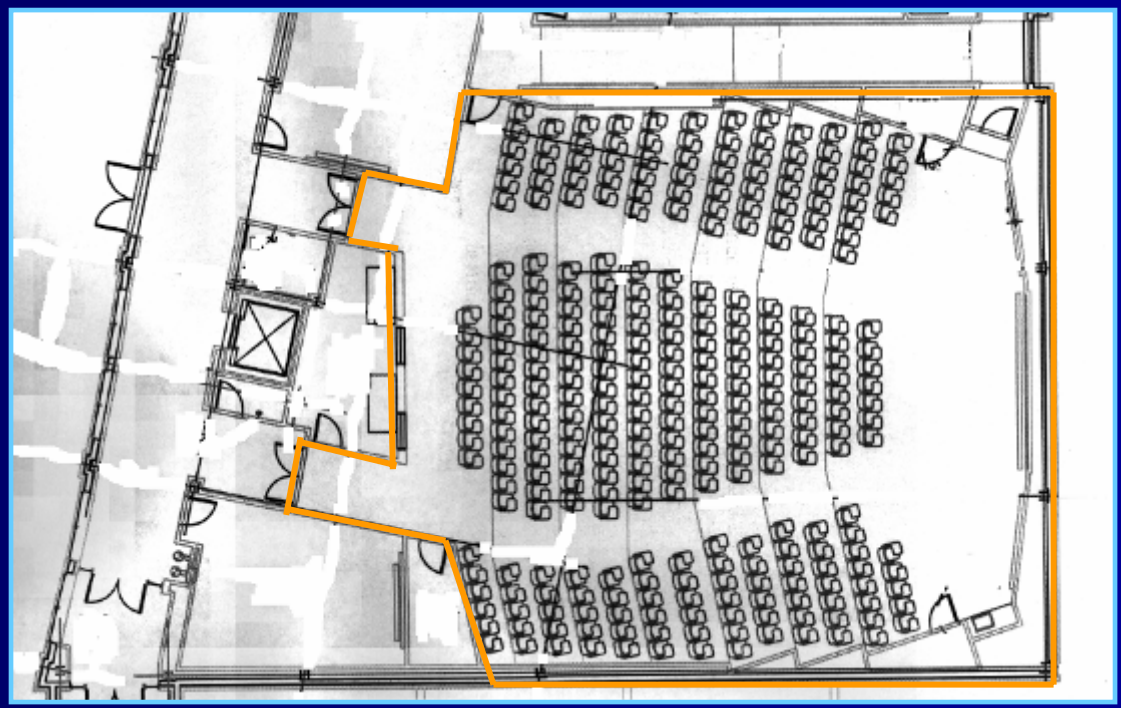
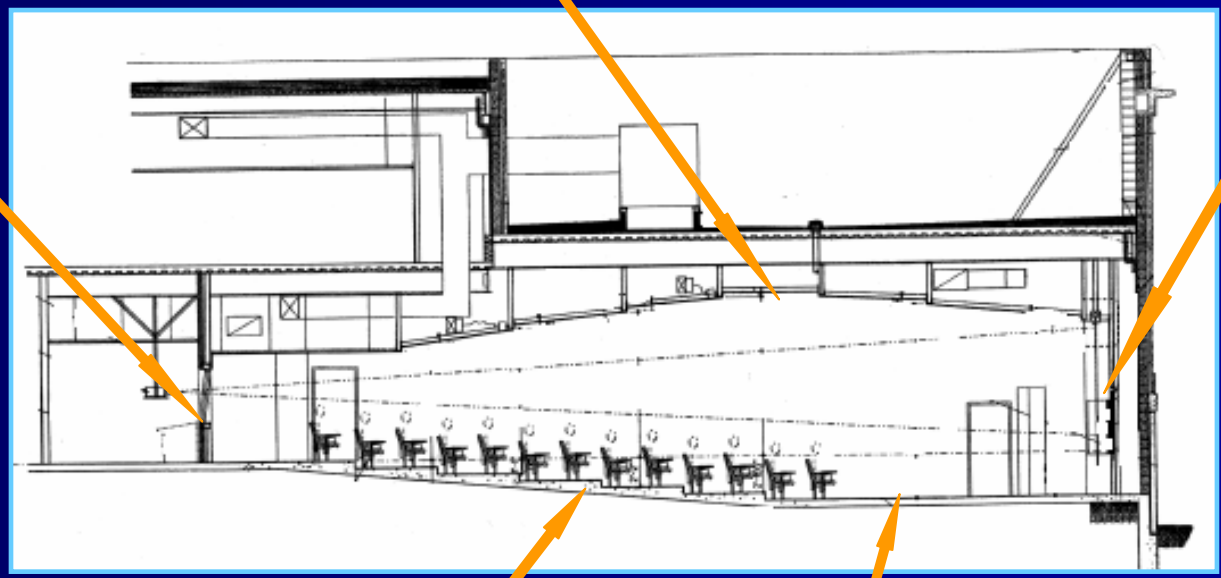
Lighting Depth- Auditorium
Location



Lighting Depth- Auditorium
Plan



Lighting Depth- Auditorium
Elevation



Lighting Depth- Auditorium

Design Considerations

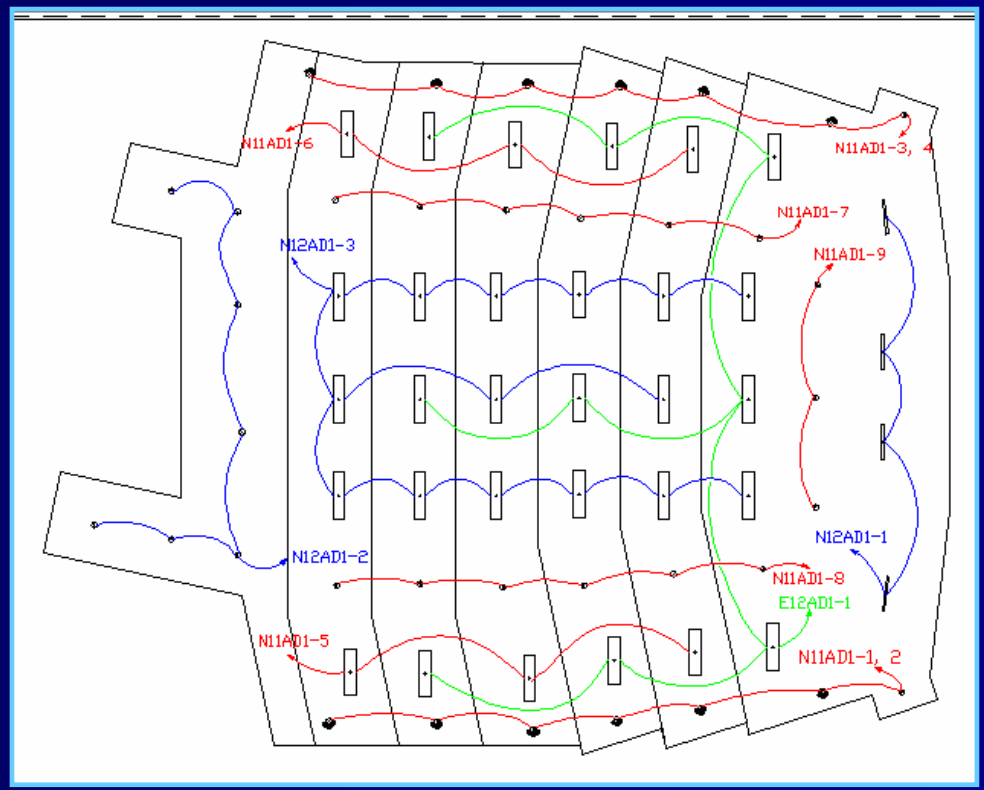
- Focal Points:
  - Speaker
  - Marker boards
- Task dependent flexibility in light levels

Lighting Depth- Auditorium

Design Goals

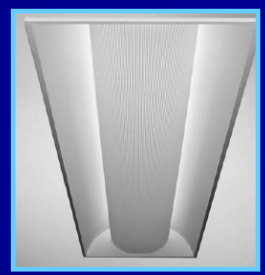
- Draw attention to front of room
- Flexible system
- Academic atmosphere
- Target Illuminance: 30 fc
- ASHRAE/ IESNA 90.1 Power Allowance: 1.4W/s.f.

Lighting Depth- Auditorium
Layout



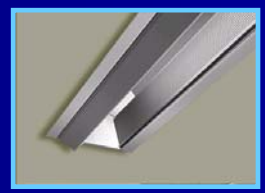
D1

(1) 13W CFL



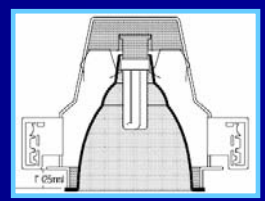
F1

(2) 32W T8



WW1

(1) 54W T5HO

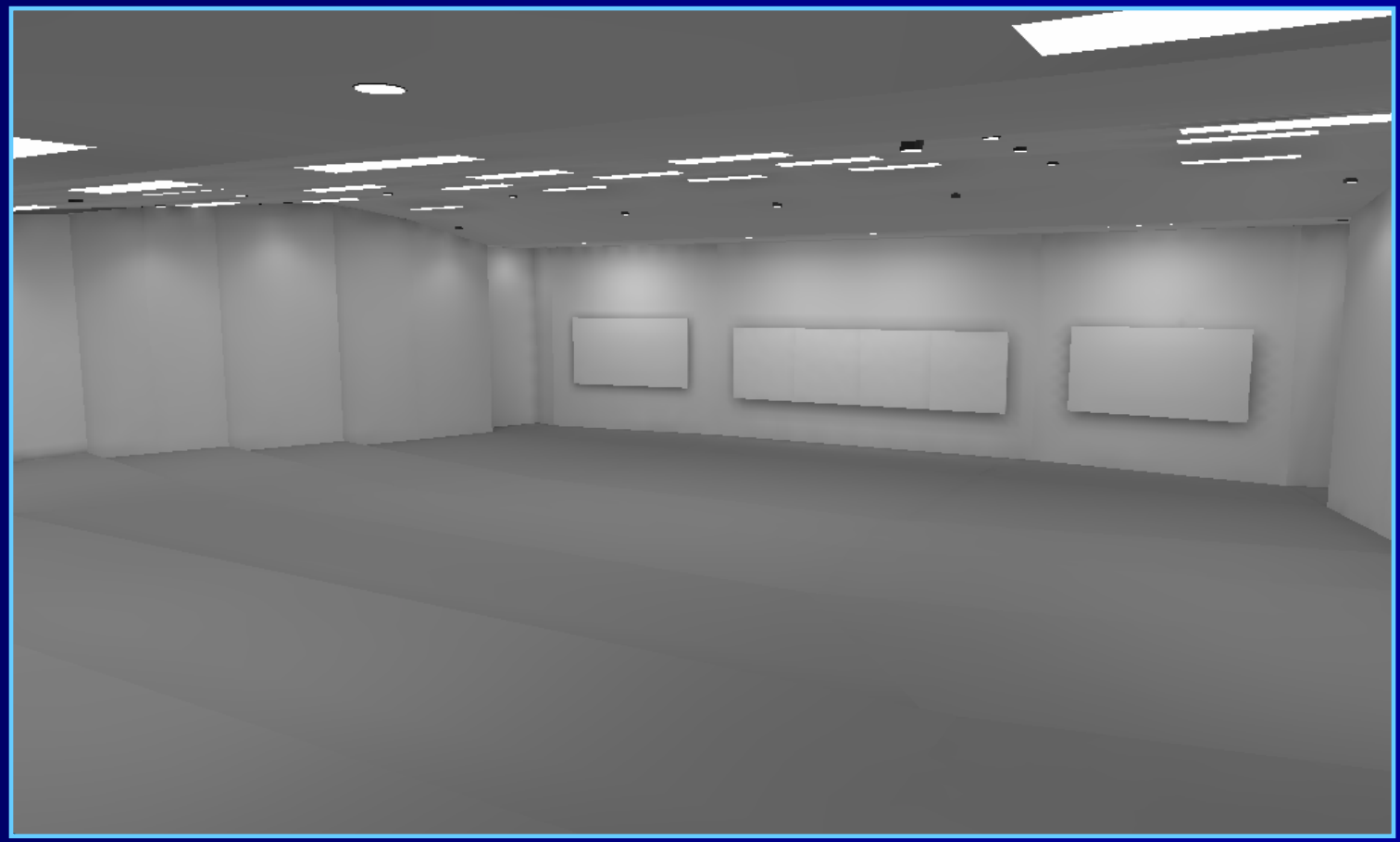


WW3

(1) 13W CFL

Lighting Depth- Auditorium

Final Design Rendering



Lighting Depth- Auditorium

Final Design Rendering

Lighting Depth- Auditorium
Conclusions

Power Allowance:

ASHRAE/IESNA 90.1 1.4 W/s.f. OK

Luminaire	#	Ballast Watts	Total Watts
D1	26	13	338
F1	60	30	1800
WW1	4	62	248
WW3	10	13	130
		TOTAL WATTS	2516
		AREA (ft2)	3875
		POWER DENSITY (W/ft2)	0.65

Target Illuminance Values:

General: 30fc

Task: 30fc

Design Illuminance Values:

General: 30fc OK

Task: 35fc OK

- Highlight white boards OK
- Flexible system OK
- Academic atmosphere OK

Presentation Outline

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- ***Electrical Depth***
- Mechanical Breadth
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Electrical Depth- Central vs. Distributed Transformers Considerations

- Number of Transformers
- Building Configuration
- Size and Space Restraints
- Cost

Electrical Depth- Central vs. Distributed Transformers

Number of Transformers

- 7 large transformers= 22 small transformers

DISTRIBUTED TRANSFORMER SIZE CALCULATION																							
Current Transformer Tag		T-500				T-225K			T-45			T-75		T-300			T-45			T-75			
Panel Serving		NG1WL	N11WL	N21WL	N31WL	N11CL	N21CL	N31CL	N11C	N21C	N31C	N11A	N21A	NG1EL	N21EL	N31EL	N11W	N21W	N31W	NG1E	N11E	N21E	N31E
Transformer	Size (kVA)	75	112.5	112.5	112.5	30	75	75	30	15	15	112.5	15	75	45	112.5	30	15	15	75	15	15	15
	Secondary Protection	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Primary Protection	110	175	175	175	45	110	110	45	20	20	175	20	110	70	175	45	20	20	110	25	20	20
Primary Design Load (A)		97.58	120.74	123.29	119.38	35.94	79.84	87.06	27.06	5.11	3.31	117.43	19.85	107.20	61.65	120.89	40.15	4.81	14.73	77.88	23.61	14.28	21.80
Wire Size	Phase	(3) #2	(3) #2/0	(3) #2/0	(3) #2/0	(3) #8	(3) #2	(3) #2	(3) #8	(3) #12	(3) #12	(3) #2/0	(3) #12	(3) #2	(3) #4	(3) #2/0	(3) #8	(3) #12	(3) #12	(3) #2	(3) #10	(3) #12	(3) #12
	Ground	(1) #6	(1) #6	(1) #6	(1) #6	(1) #10	(1) #6	(1) #6	(1) #10	(1) #12	(1) #12	(1) #6	(1) #12	(1) #6	(1) #8	(1) #6	(1) #10	(1) #12	(1) #12	(1) #6	(1) #10	(1) #12	(1) #12
Conduit Size		1- 1/4"	2"	2"	2"	3/4"	1- 1/4"	1- 1/4"	3/4"	3/4"	3/4"	2"	3/4"	1- 1/4"	1- 1/4"	2"	3/4"	3/4"	3/4"	1- 1/4"	3/4"	3/4"	3/4"
Secondary Design Load (A)		225.19	278.62	284.52	275.50	82.93	184.24	200.90	62.46	11.80	7.63	270.99	45.80	247.39	142.26	278.97	92.64	11.10	34.00	179.73	54.48	32.96	50.31
Wire Size	Phase	(4) #250	(4) #500	(4) #500	(4) #500	(4) #3	(4) #250	(4) #250	(4) #3	(4) #8	(4) #8	(4) #500	(4) #8	(4) #250	(4) #1/0	(4) #500	(4) #3	(4) #8	(4) #8	(4) #250	(4) #8	(4) #8	(4) #8
	Ground	(1) #2	(1) #2	(1) #2	(1) #2	(1) #8	(1) #2	(1) #2	(1) #8	(1) #10	(1) #10	(1) #2	(1) #10	(1) #2	(1) #6	(1) #2	(1) #8	(1) #10	(1) #10	(1) #2	(1) #10	(1) #10	(1) #10
Conduit Size		2- 1/2"	3- 1/2"	3- 1/2"	3- 1/2"	1- 1/4"	2- 1/2"	2- 1/2"	1- 1/4"	1"	1"	3- 1/2"	1"	2- 1/2"	2"	3- 1/2"	1- 1/4"	1"	1"	2- 1/2"	1"	1"	1"

Electrical Depth- Central vs. Distributed Transformers

Building Configuration

- Large, horizontally oriented building
- Stacked electrical rooms
- Average Area of Electrical Rooms: 81 s.f.

Electrical Depth- Central vs. Distributed Transformers

Size and Space Restraints

- Distributed System = + 805 s.f.

Physical Size Comparison				
Current		Resized		Increase in Size (H xW x D) (in.)
Transformer Tag	Physical Size (H x W x D) (in.)	Transformer Tag	Physical Size (H x W x D) (in.)	
T-500	75 x 44- 1/2 x 36	75	39/ 3/8 x 26- 1/8 x 19- 1/8	82.5 x 60 x 40.5
		112.5	39- 3/8 x 26- 1/8 x 19- 1/8	
		112.5	39- 3/8 x 26- 1/8 x 19- 1/8	
		112.5	39- 3/8 x 26- 1/8 x 19- 1/8	
T-300	62- 1/4 x 31- 1/4 x 30- 1/4	75	39/ 3/8 x 26- 1/8 x 19- 1/8	46- 5/8 x 41- 1/8 x 22- 1/8
		45	30 -1/8 x 20- 1/8 x 14- 1/8	
		112.5	39- 3/8 x 26- 1/8 x 19- 1/8	
T-225K	56 x 31- 1/4 x 24- 1/4	30	30- 1/8 x 20- 1/8 x 14- 1/8	52- 7/8 x 41- 1/8 x 28- 1/8
		75	39/ 3/8 x 26- 1/8 x 19- 1/8	
		75	39/ 3/8 x 26- 1/8 x 19- 1/8	
T-75	39- 3/8 x 26- 1/8 x 19- 1/8	112.5	39- 3/8 x 26- 1/8 x 19- 1/8	25 x 20- 1/8 x 14- 1/8
		15	25 x 20- 1/8 x 14- 1/8	
T-75	39- 3/8 x 26- 1/8 x 19- 1/8	75	39/ 3/8 x 26- 1/8 x 19- 1/8	75 x 60- 3/8 x 42- 3/8
		15	25 x 20- 1/8 x 14- 1/8	
		15	25 x 20- 1/8 x 14- 1/8	
		15	25 x 20- 1/8 x 14- 1/8	
T-45	30- 1/8 x 20- 1/8 x 14- 1/8	30	30- 1/8 x 20- 1/8 x 14- 1/8	50 x 40- 1/4 x 28- 1/4
		15	25 x 20- 1/8 x 14- 1/8	
		15	25 x 20- 1/8 x 14- 1/8	
T-45	30- 1/8 x 20- 1/8 x 14- 1/8	30	30- 1/8 x 20- 1/8 x 14- 1/8	50 x 40- 1/4 x 28- 1/4
		15	25 x 20- 1/8 x 14- 1/8	
		15	25 x 20- 1/8 x 14- 1/8	

Electrical Depth- Central vs. Distributed Transformers

Cost

- Distributed System= + $10,380.00

Cost Comparison				
Current		Resized		Cost Difference (U.S. $)
Transformer Tag	Cost (U.S. $)	Transformer Tag	Cost (U.S. $)	
T-500	16,000	75	2,970	-130
		112.5	4,300	
		112.5	4,300	
		112.5	4,300	
T-300	10,000	75	2,970	-630
		45	2,100	
		112.5	4,300	
T-225K	7,900	30	1,725	-235
		75	2,970	
		75	2,970	
T-75	2,970	112.5	4,300	+2,680
		15	1,350	
T-75	2,970	75	2,970	+4,050
		15	1,350	
		15	1,350	
		15	1,350	
T-45	2,100	30	1,725	+2,325
		15	1,350	
		15	1,350	
T-45	2,100	30	1,725	+2,325
		15	1,350	
		15	1,350	
			TOTAL	+ 10,380

Electrical Depth- Central vs. Distributed Transformers

Conclusions

- Distributed System =
  - Increased number of transformers
  - Increased area of equipment
  - Increased cost
- Central Transformer System is best

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Mechanical Breadth- Low Emissions Generator

Considerations

- Existing versus Modified System
- Feasibility
- Initial Cost
- Energy

Mechanical Breadth- Low Emissions Generator

Existing System

- Eight Roof Top Units
- Power
  - Three Motor Control Centers
  - Utility

Mechanical Breadth- Low Emissions Generator

Modified System

- Utility Power
  - Two motor control centers
- Low Emissions Generator
  - One motor control center
  - All eight roof top units
  - 480/277V, 60 Hz, 1250 kW generator
  - Produces domestic hot water

Mechanical Breadth- Low Emissions Generator

Feasibility

- Process exhaust stream created for generator set
- Inefficiencies
  - Creation of process exhaust stream
  - Heat exchangers in the flue system

Mechanical Breadth- Low Emissions Generator

Initial Cost

- Low emissions generator set= + $164,030.00

INITIAL COSTS			
MODIFIED			
Equip.	Amt.	Bare Mat. Cost (U.S. $)	Total Equip. Cost
GEN SET	1	$142,500.00	$142,500.00
6" PIPE	500	$32.50	$16,250.00
T's	30	$106.00	$3,180.00
90's	30	$70.00	$2,100.00
		TOTAL	$164,030.00

Mechanical Breadth- Low Emissions Generator

Energy- Utility

CURRENT SYSTEM- MONTHLY ELECTRIC COSTS					
Enter the kw for the desired system		Billing Months of June-October	kw	Billing Months of November- May	kw
			492		91
GENERATION					
kW-hr Charge	On Peak	$0.08682 per kW-h	$1,709.38	$0.06889 per kW-h	$250.44
	Intermediate	$0.06632 per kW-h	$1,305.76	$0.07239 per kW-h	$263.17
	Off Peak	$0.05645 per kW-h	$2,445.15	$0.05757 per kW-h	$460.44
kW Charge	On Peak	$0.84507 per kW	$415.96		
	Maximum	$0.30248 per kW	$148.89	$0.30248 per kW	$27.49
TRANSMISSION					
All kW-h		$0.00111 per kW-h	$91.79	$0.00111 per kW-h	$16.95
kW Charge	On Peak	$0.71000 per kW	$349.48		
	Maximum	$0.59000 per kW	$290.41	$0.59000 per kW	$53.62
DISTRIBUTION					
Customer Charge		$20.93000 per month	$20.93	$20.90000 per month	$20.90
All kW-h		$0.01029 per kW-h	$850.91	$0.01029 per kW-h	$157.11
kW Charge	Maximum	$4.80000 per kW	$2,362.66	$4.80000 per kW	$436.25
Delivery Tax		$0.00770 per kW-h	$636.74	$0.00770 per kW-h	$117.57
Public Space Occupancy Surcharge		$0.00154 per kW-h	$127.35	$0.00159 per kW-h	$24.28
Reliability Energy Trust Fund		$0.00065 per kW-h	$53.75	$0.00065 per kW-h	$9.92
Gneration Procurement Credit		$0.00002 per kW-h	$1.65	$0.00002 per kW-h	$0.31
SUB-TOTAL			$10,810.80		$1,838.45
Subtracting once monthly charges			$415.96		$0.00
			$148.89		$27.49
			$349.48		$0.00
			$290.41		$53.62
			$20.93		$20.90
			$2,362.66		$436.25
Billing for average 7 day week less demand and peak charges			$7,222.48		$1,300.19
Billing for 1 month less demand and peak charges			$28,889.93		$5,200.75
Billing for 1 month of electrical service			**$32,478.25**		**$5,739.01**
Yearly Cost of Electrical Service				**$202,564.28**	

- Existing system= $202,564.28 per year

Mechanical Breadth- Low Emissions Generator

Energy- Natural Gas

MODIFIED SYSTEM- MONTHLY NATURAL GAS COSTS			
Enter the therms for the desired system	Billing Months of January-Decebmer		Therms
			12,092.40
SYSTEM			
Heating and/or Cooling	$17.00000	per month	$17.00
Non-heating and Non-cooling	$11.75000	per month	$11.75
MONTHLY			
January	$1.0957	per therm	$13,249.64
February	$1.0957	per therm	$13,249.64
March	$0.9833	per therm	$11,890.46
April	$0.9833	per therm	$11,890.46
May	$0.9390	per therm	$11,354.76
June	$0.7543	per therm	$9,121.30
July	$0.7543	per therm	$9,121.30
August	$0.7331	per therm	$8,864.94
September	$0.8568	per therm	$10,360.77
October	$0.8603	per therm	$10,403.09
November	$0.9512	per therm	$11,502.29
December	$1.0957	per therm	$13,249.64
DISTRIBUTION			
First 125 therms	$0.30930	per therm	$3,740.18
Next 875 therms	$0.25030	per therm	$0.00
Over 1,000 therms	$0.19030	per therm	$0.00
SUBTOTAL MONTHLY COSTS			$3,768.93
Monthly Costs Incurred Over a Year			$45,227.15
Yearly Cost of Natural Gas			**$179,485.44**

- Modified System= $179,488.44 per year

Mechanical Breadth- Low Emissions Generator

Conclusions

- Feasibility
- Initial Cost
- Energy

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Conclusion

- Lighting Depth
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- Electrical Depth
  - Central vs. Distributed Transformer System
- Mechanical Breadth
  - Low Emissions Generator

Presentation Outline

- Building Overview
- Lighting Depth
  - Lobby
  - Auditorium
- Electrical Depth
- Mechanical Breadth
- Conclusion
- *Questions*

Questions