- LIGHTING CASE STUDY #1 -

"A Daylighted Room"

[THE SHOP CRIT.]

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[THE SHOP CRIT.]

GENERAL BUILDING DESCRIPTION

- THE SHOP-CRIT IS A SPACE PRIMARILY USED BY ARCHITECTURE STUDENTS AND STAFF TO CONVENE FOR **PRESENTATIONS**, **CLASSES**, AND **MEETINGS**. IT IS LOCATED ON THE NORTH-EAST SIDE OF AAN & AAS ATTACHED TO THE EASTERN SIDE OF THE WOOD SHOP.

- THE ONLY DAYLIGHTING SYSTEM USED IN THE ROOM IS THE **LARGE GLAZING WALL** THAT MAKES UP THE **NORTH SIDE** OF THE ROOM. WHEN THE GLAZING WALL IS CLOSED OFF, OR THE DAYLIGHTING IS NOT USED, THE ROOM IS HEAVILY DEPENDENT ON DISPERSED **ELECTRICAL FLUORESCENT** & **SPOT LIGHTING.**

[CURRENT LIGHT PERFORMANCE.]

DAYLIGHTING SCHEME

- The only current daylighting scheme is the 24'x9' **GLAZING WALL SYSTEM** on the north side of the room. It takes up the entire wall, and has sliding glass doors that open to the outside allowing for fresh air in the warmer months.
- The north side of the building receives **MINIMAL LIGHT**, and is partially shaded by large deciduous and coniferous trees in the morning hours. At the same time that there isn't enough natural daylight to make the room usable,
- to prevent **GLARE** when giving presentations via the large projector, heavy black curtains were implemented to close off the glazing wall, concealing the room.

[LIGHT PERFORMANCE ANALYSIS]

ILLUMINANCE FOOTPRINT

The space was analyzed February 10th at 1:45 pm.

Units? FC?
North up?

[CURRENT LIGHT PERFORMANCE.]

ELECTRICAL LIGHTING SCHEME

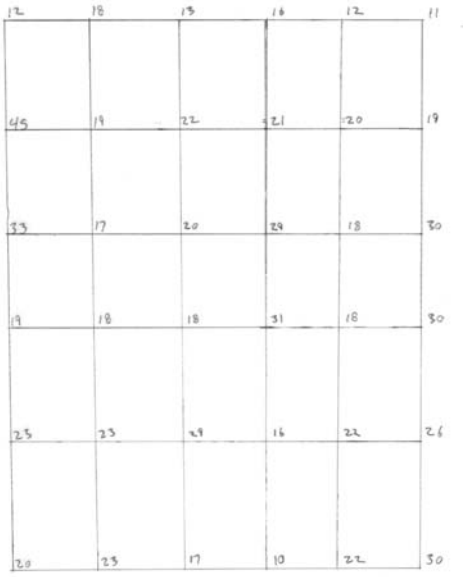
- (31) Spot Lighting (including "Blob" Installation)
  - Sylvania 50w J3NFL 130v
    - Color Temperature of 2825k
    - CRI = 99
    - Life of 2,500 hours
- (28) Fluorescents
  - Sylvania 32w Octron XP
    - Color Temperature of 4100k
    - CRI = 82
    - Life of 24,000 hours

[LIGHT PERFORMANCE ANALYSIS]

ELECTRICAL LIGHTING SWEEP - NIGHT TIME -

Analysis was taken February 12th at 5:20 pm

All lamps turned on?



[ENERGY USAGE]

ELECTRIC LIGHTING SYSTEM

INVENTORY:

- FLUORESCENTS (28 BULBS TOTAL)
  - SYLVANIA 32W OCTRON XP
  - COLOR TEMPERATURE OF 4100K
  - CRI = 82
  - LIFE OF 24,000 HOURS

(28 BULBS X 32W) = RESULTS IN 896W /HOUR

- SPOT LIGHTING (31 BULBS TOTAL)
  - SYLVANIA 50W J3NFL 130V
  - COLOR TEMPERATURE OF 2825K
  - CRI = 99
  - LIFE OF 25,000 HOURS

(31 BULBS X 50W) = RESULTS IN 1550W /HOUR

896W + 1550W =

TOTAL: 2446W /HOUR OR...

[2.446 KW/HR] X [5 HR/DAY] X [260 DAYS/YEAR] = 3179.8 KW/YR

[LIGHTING ZONES]

SHOP CRIT.

- SPOT LIGHTS
- FLUORESCENTS
- DAYLIGHTING

[MOSCOW, ID CLIMATE]

SKY COVER MONTHLY NORMALS

Eighths of sky covered, % days for each sky condition

Moscow's climate is predominantly Overcast.

Hr	J	F	M	A	M	J	J	A	S	O	N	D	Total
Clear Days	8	8	7	7	7	7	10	10	10	10	5	6	95
Pt Cloudy Days	7	7	7	8	9	10	12	11	8	7	6	6	101
Overcast Days	15	14	17	15	15	12	9	10	12	14	18	18	169
% Clear	27	28	23	23	23	24	32	32	33	32	17	20	26%
% Pt Cloudy	23	24	23	27	29	34	39	35	27	23	21	20	28%
% Overcast	50	48	55	50	48	41	29	32	40	45	62	60	46%

[CONT.]

DAYLIGHT AVAILABILITY

- Mean Hourly Horizontal Illuminance in Foot-candles
- Moscow's climate provides full opportunity to access daylight between 9:00am-5:00pm

	J	F	M	A	M	J	J	A	S	O	N	D
1 AM	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	89	471	697	477	179	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	145	787	1807	1899	1591	1089	453	100	0	0
7	0	221	996	1975	3186	9368	3234	2572	1633	834	211	0
8	551	1165	2282	3429	4489	4780	4801	3976	2777	1897	961	532
9	1572	2423	3444	4556	5270	6113	6111	5263	4314	3068	1939	1375
10	2698	3688	4614	5313	6373	7440	7084	6371	5104	3550	2345	2160
11	3106	4272	5505	5687	7261	7783	7052	6813	5778	4364	2970	2524
12PM	3204	4590	5460	5836	7167	8145	7500	6946	5778	4470	2930	2787
1	3101	4352	5083	5443	6840	7360	7060	5478	5631	3956	2391	2287
2	2309	3583	4274	4613	5834	6748	6351	5134	4565	2912	1760	1657
3	1352	2418	3224	3886	4697	5197	5592	4724	3554	1947	988	828
4	385	1139	1807	2532	3522	3839	4179	3248	2127	832	211	49
5	0	192	651	1225	2013	2493	2713	1641	724	102	0	0
6	0	0	37	293	806	1224	1209	606	73	0	0	0
7	0	0	0	0	97	269	233	24	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12AM												

<0
0-100
100-500
500-1000
1000-2000
>2000

[DESIGN PROPOSAL]

GOAL:

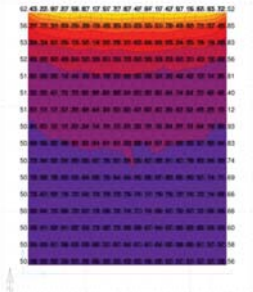
To improve light distribution throughout the room while maintaining enough luminosity to properly work in the environment

EXPERIMENT:

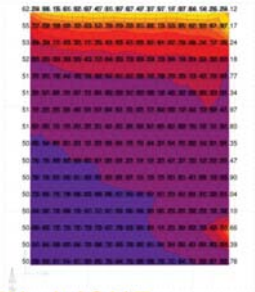
To find the most appropriate daylighting solution between skylights and sidelights.

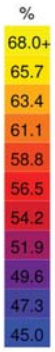
[REDESIGN COMPARISONS]

DAYLIGHTING AS DESIGNED

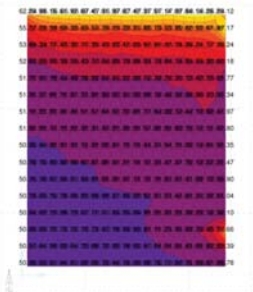


REDESIGNED

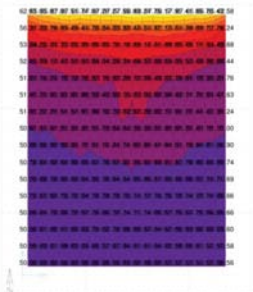




SIDE LIGHT



SKY LIGHT



[GLARE COMPARISON]

BEFORE

AFTER

60

40

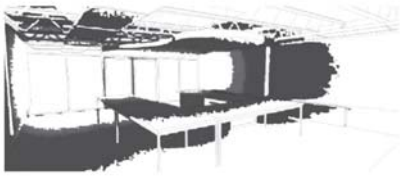
0 FC

SIDE LIGHTS

SKYLIGHT

[GLARE COMPARISONS CONT.]

LIGHT INTENSITY BEFORE

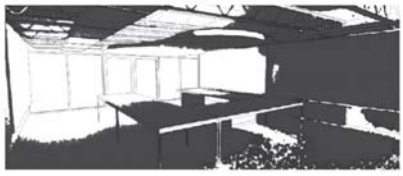


AFTER

- Through isolating the bands of light, differences can be spotted among the design alternatives

SIDE LIGHTS

SKYLIGHT



[REDESIGN COMPARISONS]

SAVINGS

- The Original Design required Electrical Lights while in use, with a Total of 2.446 kw/hr, resulting in approximately 3179.8 kw/year.

[2.446 kw/hr] x [5 hr/day] x [260 days/year] = 3179.8 kw/year

- The new design requires electrical lights, with a Total of 2.446 kw/hr, only in very few circumstances (roughly one hour in 130 days of the year) resulting in only approximately 317.98 kw/year.

[2.446 kw/hr] x [1 hr/day] x [130 days/year] = 317.98 kw/year

- This would save approximately 2861.82 kw/year!

2,861.82 KWH/Year (units)

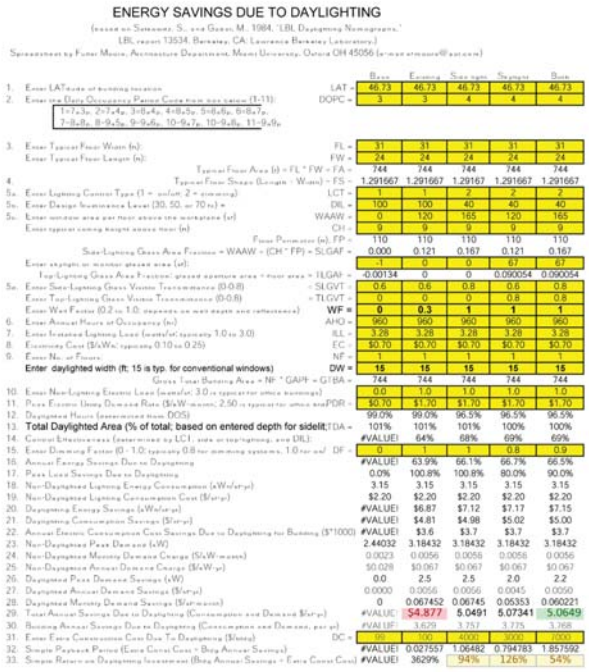
[REDESIGN COMPARISONS]

ENERGY SAVINGS

- Any daylight solution is an improvement upon existing conditions.

- Using side lights and sky lights provides the least dependency of artificial lighting, however initial cost and increased heat dissipation through exterior glazing may offset savings in the long run.

Maybe...



ENERGY SAVINGS DUE TO DAYLIGHTING

		Base	Existing	Side-ops	Skylights	Both
1. Enter LAT=lat of building location	LAT =	46.73	46.73	46.73	46.73	46.73
2. Enter the Daily Occupancy Period Code from key above (1-11):	DOPC =	3	3	4	4	4
1=7-3p, 2=7-4p, 3=8-4p, 4=8-5p, 5=8-6p, 6=8-7p, 7=8-8p, 8=9-5p, 9=9-6p, 10=9-7p, 10=9-8p, 11=9-9p						
3. Enter Typical Floor Width (ft):	FL =	31	31	31	31	31
Enter Typical Floor Length (ft):	FW =	24	24	24	24	24
Typical Floor Area (s) = FL * FW = FA =		744	744	744	744	744
4. Typical Floor Shape (Length : Width) = FS =		1.291667	1.291667	1.291667	1.291667	1.291667
5a. Enter Lighting Control Type (1 = on/off, 2 = dimming)	LCT =	1	1	2	2	2
5b. Enter Design Illuminance Level (30, 50, or 70 fc) =	DIL =	100	100	40	40	40
5c. Enter window area per floor above the workplane (sf)	WAAW =	0	120	165	120	165
Enter typical ceiling height above floor (ft)	CH =	9	9	9	9	9
Floor Perimeter (m), FP =		110	110	110	110	110
Side-Lighting Glass Area Fraction = WAAW ÷ (CH * FP) = SLGAF =		0.000	0.121	0.167	0.121	0.167
Enter skylight or monitor glazed area (sf):		1	0	0	67	67
Top-Lighting Glass Area Fraction: glazed aperture area ÷ floor area = TLGAF =		-0.00134	0	0	0.090054	0.090054
5d. Enter Side-Lighting Glass Visible Transmittance (0-0.8)	- SLGVT =	0.6	0.6	0.8	0.6	0.8
Enter Top-Lighting Glass Visible Transmittance (0-0.8)	- TLGVT =	0	0	0	0.8	0.8
Enter Well Factor (0.2 to 1.0; depends on well depth and reflectance)	WF =	0	0.3	1	1	1
6. Enter Annual Hours of Occupancy (hr)	AHO =	960	960	960	960	960
7. Enter Installed Lighting Load (watts/sf; typically 1.0 to 3.0)	ILL =	3.28	3.28	3.28	3.28	3.28
8. Electricity Cost ($/kWh; typically 0.10 to 0.25)	EC =	$0.70	$0.70	$0.70	$0.70	$0.70
9. Enter No. of Floors:	NF =	1	1	1	1	1
Enter daylighted width (ft; 15 is typ. for conventional windows)	DW =	15	15	15	15	15
Gross Total Building Area = NF * GAPF = GTBA =		744	744	744	744	744
10. Enter Non-Lighting Electric Load (watts/sf; 3.0 is typical for office buildings)		1.0	1.0	1.0	1.0	1.0
11. Peak Electric Utility Demand Rate ($/kW/month; 2.50 is typical for office and PDR)		$0.70	$1.70	$1.70	$1.70	$1.70
12. Daylighted Hours (percentage from DOS)		99.0%	99.0%	96.5%	96.5%	96.5%
13. Total Daylighted Area (% of total; based on entered depth for sidelit)	TDA =	101%	101%	101%	100%	100%
14. Control Effectiveness (determined by LCI, side or toplighting, and DIL):		#VALUE!	64%	68%	69%	69%
15. Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems, 1.0 for on/ off)	DF =	0	1	1	0.8	0.9
16. Annual Energy Savings Due to Daylighting		#VALUE!	63.9%	66.1%	66.7%	66.5%
17. Peak Load Savings Due to Daylighting		0.0%	100.8%	100.8%	80.0%	90.0%
18. Non-Daylighted Lighting Energy Consumption (kW/sf-yr)		3.15	3.15	3.15	3.15	3.15
19. Non-Daylighted Lighting Consumption Cost ($/sf-yr)		$2.20	$2.20	$2.20	$2.20	$2.20
20. Daylighting Energy Savings (kW/sf-yr)		#VALUE!	$6.87	$7.12	$7.17	$7.15
21. Daylighting Consumption Savings ($/sf-yr)		#VALUE!	$4.81	$4.98	$5.02	$5.00
22. Annual Electric Consumption Cost Savings Due to Daylighting for Building ($*1000)		#VALUE!	$3.6	$3.7	$3.7	$3.7
23. Non-Daylighted Peak Demand (kW)		2.44032	3.18432	3.18432	3.18432	3.18432
24. Non-Daylighted Monthly Demand Charge ($/kW-month)		0.0023	0.0056	0.0056	0.0056	0.0056
25. Non-Daylighted Annual Demand Charge ($/kW-yr)		$0.028	$0.067	$0.067	$0.067	$0.067
26. Daylighted Peak Demand Savings (kW)		0.0	2.5	2.5	2.0	2.2
27. Daylighted Annual Demand Savings ($/sf-yr)		0.0000	0.0056	0.0056	0.0045	0.0050
28. Daylighted Monthly Demand Savings ($/sf-month)		0	0.067452	0.06745	0.05353	0.060221
29. Total Annual Savings Due to Daylighting (Consumption and Demand $/sf-yr)		#VALUE!	$4.877	$5.0491	$5.07341	$5.06649
30. Building Annual Savings Due to Daylighting (Consumption and Demand, per yr)		#VALUE!	3,629	3,757	3,775	3,768
31. Enter Extra Construction Cost Due To Daylighting ($/sf)	DC =	99	100	4000	3000	7000
32. Simple Payback Period (Extra Const Cost ÷ Daily Annual Savings)		#VALUE!	0.027557	1.06482	0.794783	1.857592
33. Simple Return on Daylighting Investment (Daily Annual Savings ÷ Extra Const Cost)		#VALUE!	3629%	94%	126%	54%