Characterisation of daylight quality by computation of performance indicators and rendering with Radiance

Radiance WorkShop 2004, Fribourg

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Image : Nicolas Roy, 2004

Which design option will give the best daylighting ?

What is daylight quality ?

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Method
Performance indicators:

1. Average luminance 40º band
2. Cylindrical illuminance
3. Daylight glare index
4. Daylight factor (overcast sky)
5. Horizontal illuminance
6. Illuminance on cube
7. Vertical-to-horizontal illuminance ratio

Method
Performance indicators:

1. Average luminance 40º band
2. Cylindrical illuminance
3. Daylight glare index
4. Daylight factor (overcast sky)
5. Horizontal illuminance
6. Illuminance on cube
7. Vertical-to-horizontal illuminance ratio
8. Sunlight patch (position, size, luminance)
9. Luminance difference (LD) index
10. Luminance ratios
11. Scale of shadow

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Method

Skies :

- Overcast
- Intermediate
- Sunny

Orientations :

- South
- West (East symmetrical)
- North

Method

Skies :

Overcast
Intermediate
Sunny

With DRY weather data
(-B, -R options in gensky)

Orientations :

South
West (East symmetrical)
North

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Method
Sunlight patch (position, size, intensity)

Mar 21, 08:00

Mar 21, 09:00

Mar 21, 10:00

Mar 21, 11:00

Mar 21, 12:00

Mar 21, 13:00

Mar 21, 14:00

Mar 21, 15:00

Mar 21, 16:00

Mar 21, 17:00

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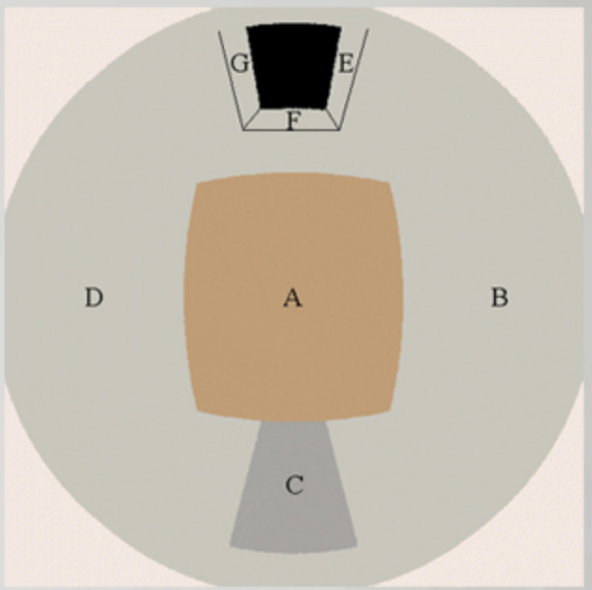
Method
Sunlight patch (position)



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	January	February	March	April	May	June
	Surface(s)	Surface(s)	Surface(s)	Surface(s)	Surface(s)	Surface(s)
06h00	-	-	-	-	-	-
07h00	-	-	-	-	-	-
08h00	-	-	-	-	-	-
09h00	-	-	-	-	-	-
10h00	-	-	-	-	-	-
11h00	-	-	-	-	-	-
12h00	-	-	-	-	-	-
13h00	E	E et F	B, E et F	A, B, E et F	A, E et F	A, E et F
14h00	B et E	B, E et F	A, B, E et F	A, B, E et F	A, E et F	A, E et F
15h00	B et E	B et E	A, B, E et F	A, B, E et F	A, E et F	A, E et F
16h00	-	B et E	A, B, C et E	A, B, C et F	A et F	A et F
17h00	-	-	C	A et C	A, C et F	A, C et F
18h00	-	-	-	C	A et C	A et C
19h00	-	-	-	C et D	C, D et G	C, D et G
20h00	-	-	-	-	D et G	D et G
21h00	-	-	-	-	-	-

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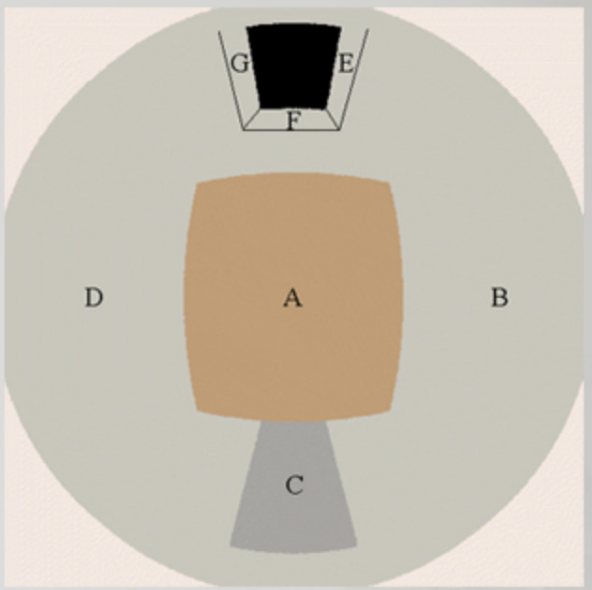
Method
Sunlight patch (position)



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	Surface(s)	Surface(s)	Surface(s)	Surface(s)	Surface(s)	Surface(s)
06h00	-	-	-	-	-	-
07h00	-	-	-	-	-	-
08h00	-	-	-	-	-	-
09h00	-	-	-	-	-	-
10h00	-	-	-	-	-	-
11h00	-	-	-	-	-	-
12h00	-	-	-	-	-	-
13h00	E	E et F	B, E et F	A, B, E et F	A, E et F	A, E et F
14h00	B et E	B, E et F	A, B, E et F	A, B, E et F	A, E et F	A, E et F
15h00	B et E	B et E	A, B, E et F	A, B, E et F	A, E et F	A, E et F
16h00	-	B et E	A, B, C et E	A, B, C et F	A et F	A et F
17h00	-	-	C	A et C	A, C et F	A, C et F
18h00	-	-	-	C	A et C	A et C
19h00	-	-	-	C et D	C, D et G	C, D et G
20h00	-	-	-	-	D et G	D et G
21h00	-	-	-	-	-	-

Position of sunlight patch

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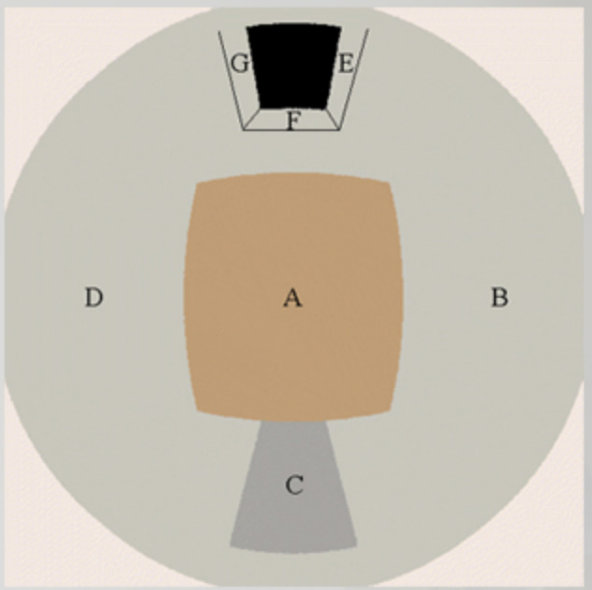
Method
Sunlight patch (position)



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06h00	-	-	-	-	-	-
07h00	-	-	-	-	-	-
08h00	-	-	-	-	-	-
09h00	-	-	-	-	-	-
10h00	-	-	-	-	-	-
11h00	-	-	-	-	-	-
12h00	-	-	-	-	-	-
13h00	E	E et F	B, E et F	A, B, E et F	A, E et F	A, E et F
14h00	B et E	B, E et F	A, B, E et F	A, B, E et F	A, E et F	A, E et F
15h00	B et E	B et E	A, B, E et F	A, B, E et F	A, E et F	A, E et F
16h00	-	B et E	A, B, C et E	A, B, C et F	A et F	A et F
17h00	-	-	C	A et C	A, C et F	A, C et F
18h00	-	-	-	C	A et C	A et C
19h00	-	-	-	C et D	C, D et G	C, D et G
20h00	-	-	-	-	D et G	D et G
21h00	-	-	-	-	-	-

Position of sunlight patch

Eliminate skies creating no sunpatch

Eliminate symmetrical sunpatchs

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Method
Sunlight patch (position)

Sunny skies

South

	JAN	FEB	MAR	APR	MAY	JUN	DEC	TOTAL
Design A	10, 12	10, 12	8, 10, 12	8, 10, 12	8, 10, 12	8, 10, 12	10, 12	18
Design B	10, 12	10, 12	8, 10, 12	8, 10, 12	8, 10, 12	8, 10, 12	10, 12	18
Design C	10, 12	10, 12	8, 10, 12	8, 10, 12	8, 10, 12	8, 10, 12	10, 12	18
								54

North

	APR	MAY	JUN	TOTAL
Design A		6, 18, 20	6, 18, 20	6
Design B	6	6, 18, 20	6, 20	6
Design C	6, 8, 18	6, 8, 10, 12, 14, 16, 18, 20	6, 8, 10, 12, 14, 16, 18, 20	19
				31

West

	JAN	FEB	MAR	APR	MAY	JUN	DEC	TOTAL
Design A	14	14,16	14, 16	14, 16, 18	14, 16, 18, 20	14, 16, 18, 20	14	17
Design B	14	14,16	14, 16	14, 16, 18	14, 16, 18, 20	14, 16, 18, 20	14	17
Design C	12, 14	12, 14, 16	12, 14, 16	10, 12, 14, 16, 18	10, 12, 14, 16, 18, 20	10, 12, 14, 16, 18, 20	12, 14	27
								61

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Method
Sunlight patch (position)

Sunny skies

South

	JAN	FEB	MAR	APR	MAY	JUN	DEC	TOTAL
Design A	10, 12	10, 12	8, 10, 12	8, 10, 12	8, 10, 12	8, 10, 12	10, 12	18
Design B	10, 12	10, 12	8, 10, 12	8, 10, 12	8, 10, 12	8, 10, 12	10, 12	18
Design C	10, 12	10, 12	8, 10, 12	8, 10, 12	8, 10, 12	8, 10, 12	10, 12	18
								54

North

	APR	MAY	JUN	TOTAL
Design A		6, 18, 20	6, 18, 20	6
Design B	6	6, 18, 20	6, 20	6
Design C	6, 8, 18	6, 8, 10, 12, 14, 16, 18, 20	6, 8, 10, 12, 14, 16, 18, 20	19
				31

West

	JAN	FEB	MAR	APR	MAY	JUN	DEC	TOTAL
Design A	14	14,16	14, 16	14, 16, 18	14, 16, 18, 20	14, 16, 18, 20	14	17
Design B	14	14,16	14, 16	14, 16, 18	14, 16, 18, 20	14, 16, 18, 20	14	17
Design C	12, 14	12, 14, 16	12, 14, 16	10, 12, 14, 16, 18	10, 12, 14, 16, 18, 20	10, 12, 14, 16, 18, 20	12, 14	27
								61

Total : 146 skies

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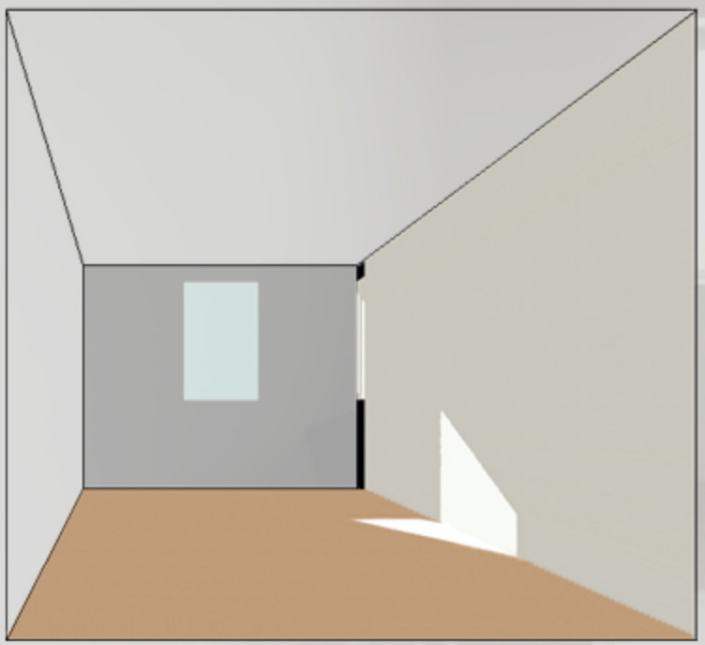
Method
Sunlight patch (size)



Mar 21, 10:00

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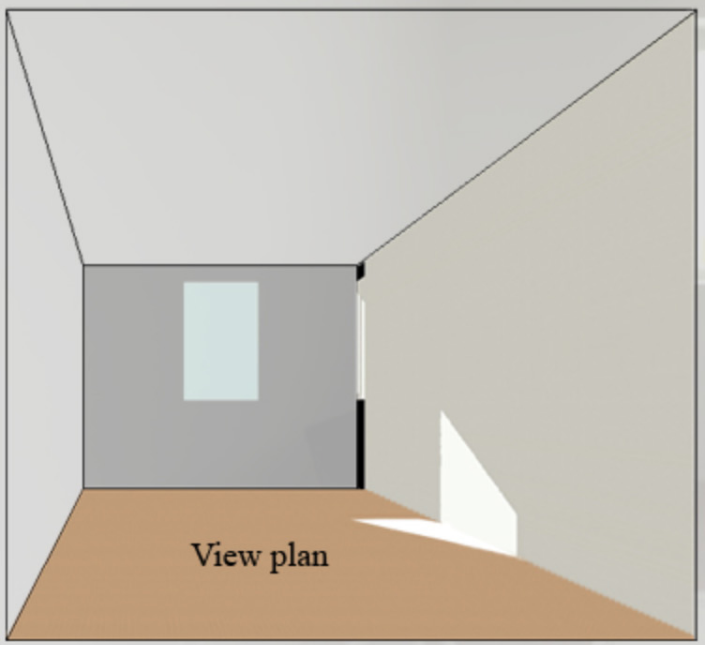
Method
Sunlight patch (size)



Mar 21, 10:00

mar_10_vplan.pic

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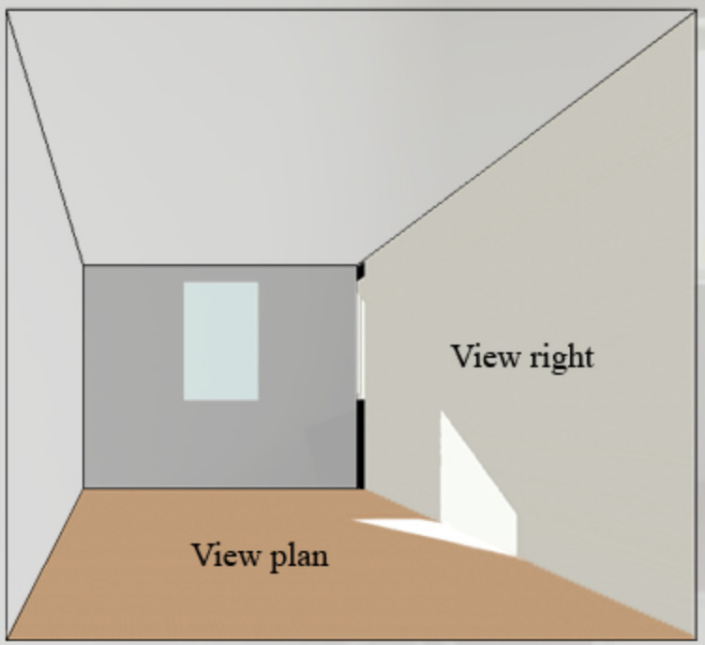
Method
Sunlight patch (size)



Mar 21, 10:00

mar_10_vplan.pic

mar_10_vright.pic

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Method
Sunlight patch (size)

mar_10_vplan.pic → mar_10_vplan.lum

mar_10_vright.pic → mar_10_vright.lum

→ Luminance for every pixel

vleft	vplan	vfen	vright	vback
0.5711	0.3832	0.5711	0.0000	0.5711
0.5711	0.3832	16.0100	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	19.8900	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	17.2900	0.5711	0.5711
0.5711	0.3832	21.1300	0.5711	0.5711

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Method
Sunlight patch (size)

Luminance for every pixel

vleft	vplan	vfen	vright	vback
0.5711	0.3832	0.5711	0.0000	0.5711
0.5711	0.3832	16.0100	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	19.8900	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	17.2900	0.5711	0.5711
0.5711	0.3832	21.1300	0.5711	0.5711

PIXELS	vleft	vplan	vfen	vright	vback	total	conversion m2
total_room(potential)	3985	5005	90	3985	3250	16315	40.79
total_image	4100	5005	90	4100	3250		
no direct sun	3980	4801	31	3640	3250		
out	115	0	0	115	0		
sunpatch	0	204	59	340	0	603	1.51
Rapport sunpatch/surface %	0.00	4.08	65.56	8.53	0.00		3.70

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Method
Sunlight patch (size)

Luminance for every pixel

vleft	vplan	vfen	vright	vback
0.5711	0.3832	0.5711	0.0000	0.5711
0.5711	0.3832	16.0100	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	19.8900	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	17.2900	0.5711	0.5711
0.5711	0.3832	21.1300	0.5711	0.5711

PIXELS	vleft	vplan	vfen	vright	vback	total	conversion m2
total_room(potential)	3985	5005	90	3985	3250	16315	40.79
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out	115	0	0	115	0		
sunpatch	0	204	59	340	0	603	1.51
Rapport sunpatch/surface %	0.00	4.08	65.56	8.53	0.00		3.70

<= 0.5711 pixel without direct sun

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Method
Sunlight patch (size)

Luminance for every pixel

vleft	vplan	vfen	vright	vback
0.5711	0.3832	0.5711	0.0000	0.5711
0.5711	0.3832	16.0100	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	19.8900	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	17.2900	0.5711	0.5711
0.5711	0.3832	21.1300	0.5711	0.5711

PIXELS	vleft	vplan	vfen	vright	vback	total	conversion m2
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Rapport sunpatch/surface %	0.00	4.08	65.56	8.53	0.00		3.70

<= 0.5711 pixel without direct sun

> 0.5711 pixel in the sunpatch

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Method
Sunlight patch (size)

Luminance for every pixel

vleft	vplan	vfen	vright	vback
0.5711	0.3832	0.5711	0.0000	0.5711
0.5711	0.3832	16.0100	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.0000	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	32.7600	0.5711	0.5711
0.5711	0.3832	19.8900	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	0.5711	0.5711	0.5711
0.5711	0.3832	17.2900	0.5711	0.5711
0.5711	0.3832	21.1300	0.5711	0.5711

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Rapport sunpatch/surface %	0.00	4.08	65.56	8.53	0.00		3.70

<= 0.5711 pixel without direct sun

> 0.5711 pixel in the sunpatch

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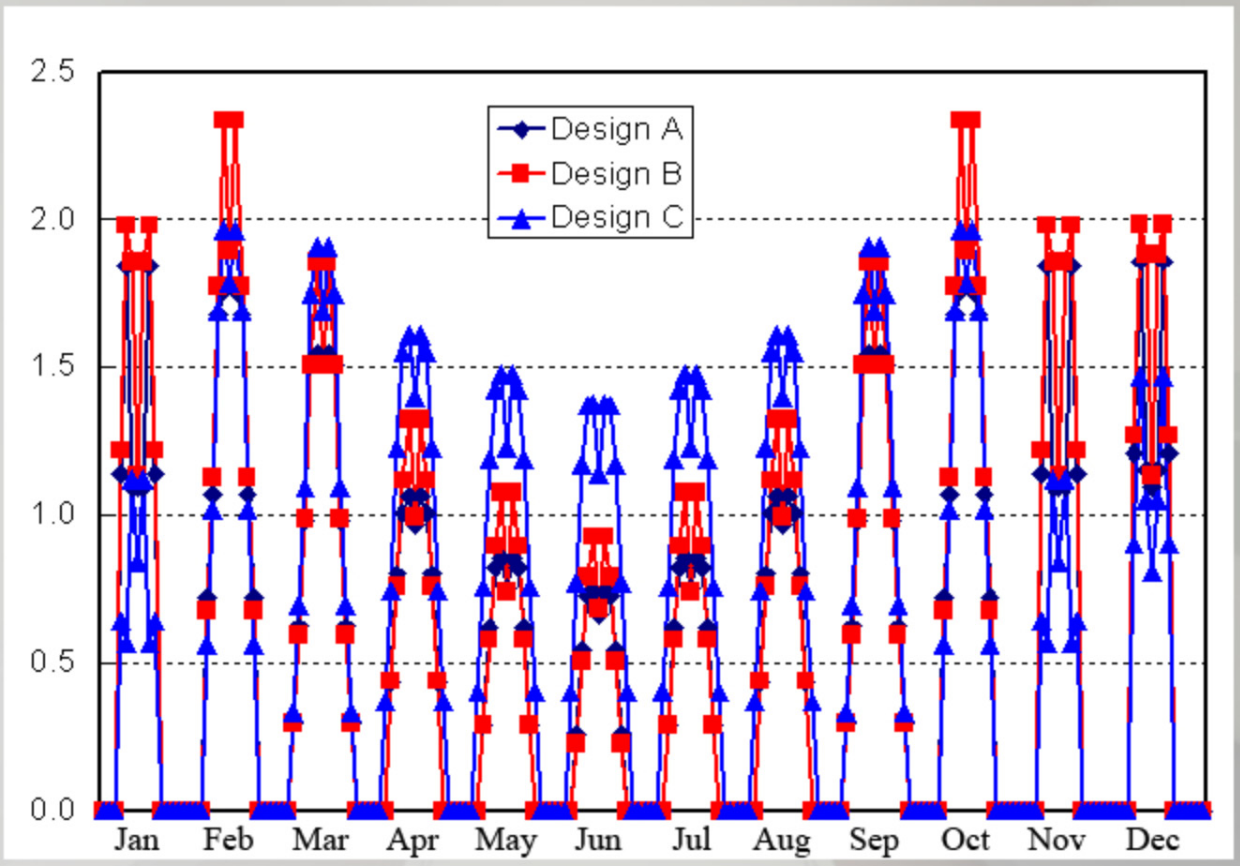
Method
Sunlight patch (size)



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Method
Luminance difference index

Lighting Res. Technol. 34,1 (2002) pp. 53–68

The Luminance Differences index: a new indicator of user preferences in daylit spaces

K Parpairi[a] DipArch.MPhil PhD, **NV Baker**[b] BSc MA PhD, **KA Steemers**[b] BsC BArch MPhil PhD and **R Compagnon**[c] PhD
[a]Hellenic Open University, Greece
[b]The Martin Centre for Architectural and Urban Studies, Department of Architecture, University of Cambridge, UK
[c]University of Applied Sciences of Western Switzerland, Ecole d'Ingenieurs et d'Architectes de Fribourg, Switzerland

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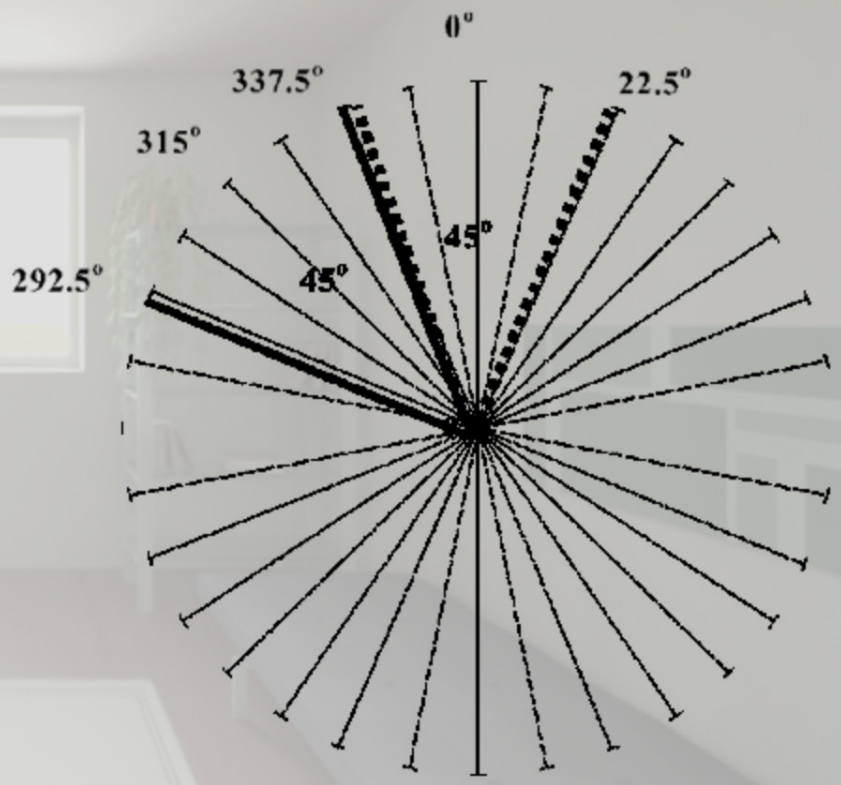
Method
Luminance difference index

Starting from **0°** the equivalent is: $\log |(L_{ave0} - L_{ave315})| + \log |(L_{ave45} - L_{ave0})| + \log |(L_{ave90} - L_{ave45})| + \log |(L_{ave135} - L_{ave90})| + \log |(L_{ave180} - L_{ave135})| + \log |(L_{ave225} - L_{ave180})| + \log |(L_{ave270} - L_{ave225})| + \log |(L_{ave315} - L_{ave270})|$.

Starting from **11.25°** the equivalent is: $\log |(L_{ave11.25} - L_{ave326.25})| + \log |(L_{ave56.25} - L_{ave11.25})| + \log |(L_{ave101.25} - L_{ave56.25})| + \log |(L_{ave146.25} - L_{ave101.25})| + \log |(L_{ave191.25} - L_{ave146.25})| + \log |(L_{ave236.25} - L_{ave191.25})| + \log |(L_{ave281.25} - L_{ave236.25})| + \log |(L_{ave326.25} - L_{ave281.25})|$.



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Method
Luminance difference index

Starting from **0°** the equivalent is: $\log |(L_{ave0} - L_{ave315})| + \log |(L_{ave45} - L_{ave0})| + \log |(L_{ave90} - L_{ave45})| + \log |(L_{ave135} - L_{ave90})| + \log |(L_{ave180} - L_{ave135})| + \log |(L_{ave225} - L_{ave180})| + \log |(L_{ave270} - L_{ave225})| + \log |(L_{ave315} - L_{ave270})|$.

Starting from **11.25°** the equivalent is: $\log |(L_{ave11.25} - L_{ave326.25})| + \log |(L_{ave56.25} - L_{ave11.25})| + \log |(L_{ave101.25} - L_{ave56.25})| + \log |(L_{ave146.25} - L_{ave101.25})| + \log |(L_{ave191.25} - L_{ave146.25})| + \log |(L_{ave236.25} - L_{ave191.25})| + \log |(L_{ave281.25} - L_{ave236.25})| + \log |(L_{ave326.25} - L_{ave281.25})|$.

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Method
Luminance difference index

Starting from **0°** the equivalent is: $\log |(L_{ave0} - L_{ave315})| + \log |(L_{ave45} - L_{ave0})| + \log |(L_{ave90} - L_{ave45})| + \log |(L_{ave135} - L_{ave90})| + \log |(L_{ave180} - L_{ave135})| + \log |(L_{ave225} - L_{ave180})| + \log |(L_{ave270} - L_{ave225})| + \log |(L_{ave315} - L_{ave270})|$.

Starting from **11.25°** the equivalent is: $\log |(L_{ave11.25} - L_{ave326.25})| + \log |(L_{ave56.25} - L_{ave11.25})| + \log |(L_{ave101.25} - L_{ave56.25})| + \log |(L_{ave146.25} - L_{ave101.25})| + \log |(L_{ave191.25} - L_{ave146.25})| + \log |(L_{ave236.25} - L_{ave191.25})| + \log |(L_{ave281.25} - L_{ave236.25})| + \log |(L_{ave326.25} - L_{ave281.25})|$.

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Method
Luminance difference index

```
oconv mat.rad skyr_apr12.rad out.rad fac.rad facframe.rad facwin.rad > fac_apr12.oct

rpict -vth -vp 1.725 2.175 1.25 -vd 0.00 -1.00 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m > fac_apr12_LD.out

rpict -vth -vp 1.725 2.175 1.25 -vd -0.20 -0.98 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @ advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m >> fac_apr12_LD.out
```

(continue until the circle is complete)

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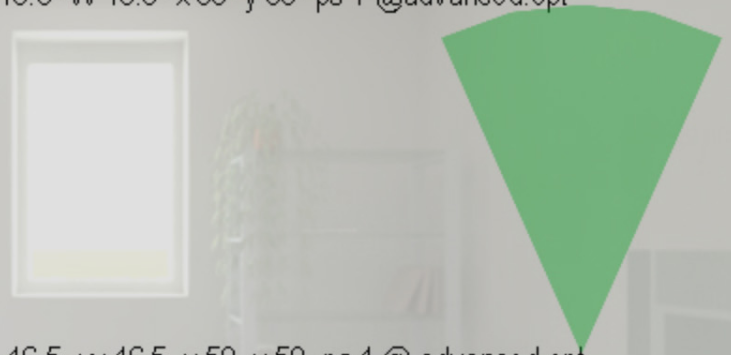
Method
Luminance difference index

```
oconv mat.rad skyr_apr12.rad out.rad fac.rad facframe.rad facwin.rad > fac_apr12.oct

rpict -vth -vp 1.725 2.175 1.25 -vd 0.00 -1.00 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m > fac_apr12_LD.out

rpict -vth -vp 1.725 2.175 1.25 -vd -0.20 -0.98 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @ advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m >> fac_apr12_LD.out

(continue until the circle is complete)
```



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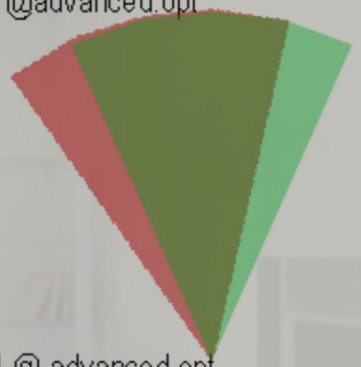
Method
Luminance difference index

```
oconv mat.rad skyr_apr12.rad out.rad fac.rad facframe.rad facwin.rad > fac_apr12.oct

rpict -vth -vp 1.725 2.175 1.25 -vd 0.00 -1.00 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m > fac_apr12_LD.out

rpict -vth -vp 1.725 2.175 1.25 -vd -0.20 -0.98 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @ advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m >> fac_apr12_LD.out

(continue until the circle is complete)
```



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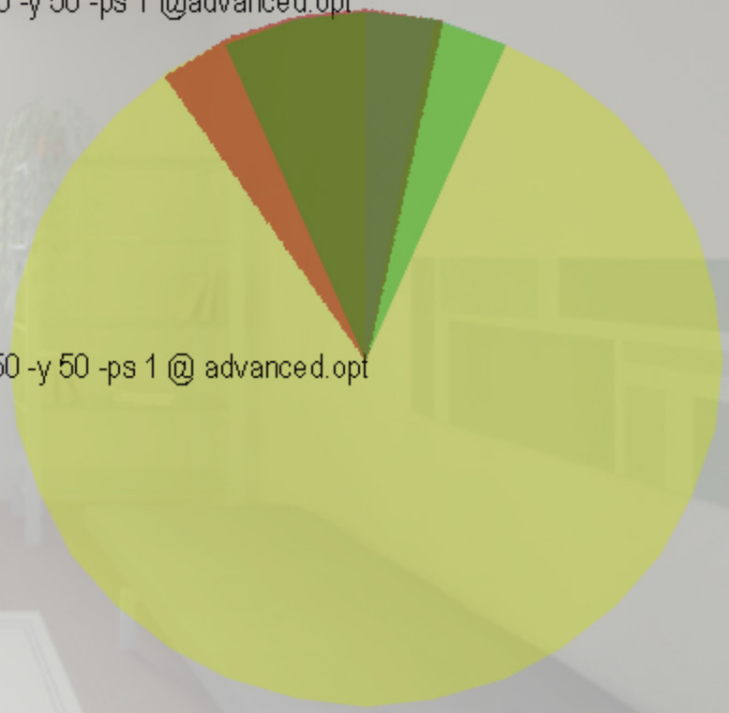
Method
Luminance difference index

```
oconv mat.rad skyr_apr12.rad out.rad fac.rad facframe.rad facwin.rad > fac_apr12.oct

rpict -vth -vp 1.725 2.175 1.25 -vd 0.00 -1.00 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m > fac_apr12_LD.out

rpict -vth -vp 1.725 2.175 1.25 -vd -0.20 -0.98 0.00 -vu 0 0 1 -vh 16.5 -vw 16.5 -x 50 -y 50 -ps 1 @ advanced.opt
fac_apr12.oct \
| pcomb -e 'sq(x):x*x' \
-e 'mult:4/PI*WE*PI*sq(sin(16.5/2*PI/180))' \
-e 'lo=if(incircle,mult*li(1),0)' \
-e 'incircle=.25-sq(x/xres-.5)-sq(y/yres-.5)' -o - \
| pvalue -h -H -d -pG \
| total -m >> fac_apr12_LD.out
```

(continue until the circle is complete)



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Method
Luminance difference index

direction	luminance output
1	314.50
2	185.56
3	11.98
4	11.20
5	12.43
6	18.19
7	18.58
8	16.44
9	14.13
10	12.07
11	10.25
12	8.63
13	7.97
14	10.52
15	11.26
16	8.65
17	7.43
18	8.14
19	9.78
20	8.59
21	7.10
22	7.85
23	8.85
24	10.06
25	11.33
26	12.58
27	13.61
28	13.97
29	9.82
30	6.58
31	7.47
32	136.60

=LOG(ABS(I3-I31))+LOG(ABS(I7-I3))+LOG(ABS(I11-I7))+LOG(ABS(I15-I11))+LOG(ABS(I19-I15))+LOG(ABS(I23-I19))+LOG(ABS(I27-I23))+LOG(ABS(I31-I27))

LDindex

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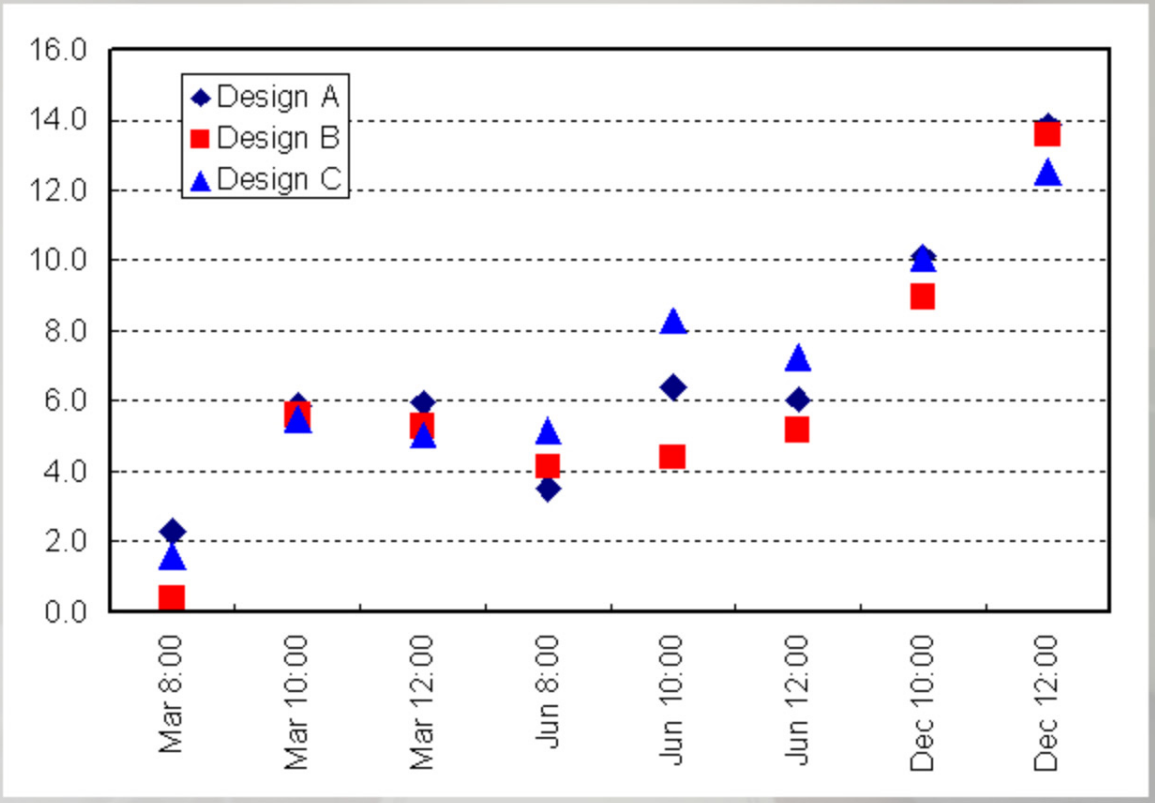
Method
Luminance difference index



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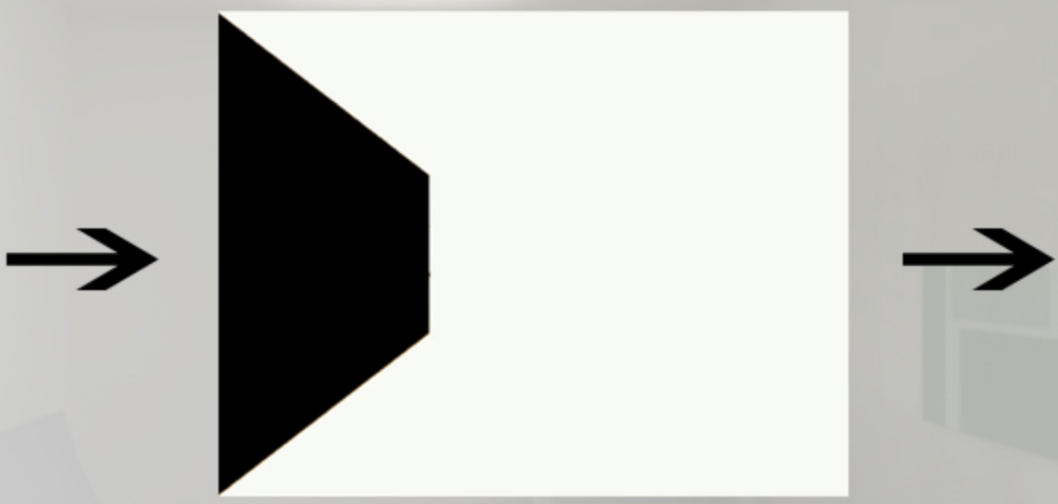
Method
Luminance ratios (between various surfaces)

```
ZONE= I 0.1 3.35 0 4.1 0 2.5
UP= Z
materials= mat.rad
scene= fac_eastwall.rad
scene= facwin_opaque.rad
scene= facframe.rad
view= vw -vf vw.vf
REPORT= 0.5
RESOLUTION= 520 400
EXPOSURE= .2
VAR= M
DET= L
QUAL= M
PENUMBRAS= FALSE
INDIRECT= 1
render= -av 100 100 100
```



rad | pfilt | pvalue > fac_eastwall_vw.lum

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Method
Luminance ratios (between various surfaces)

Identify which pixels (cells) = 0

Matrix

West wall	Ceilling	East Wall	Floor	Window wall	Window
158	187	127	62	94	8712
158	188	126	63	100	8327
160	190	127	65	103	7989
163	190	128	68	107	7686
157	192	127	69	110	7400
158	193	129	69	113	7097
163	195	129	71	116	6815
164	196	130	72	118	9240
159	198	0	74	122	8841
158	199	0	74	126	8499
159	199	0	76	131	8155
164	199	0	77	136	7855
165	200	0	79	143	7570
164	202	0	80	151	7269
161	204	0	80	159	6986
160	205	0	81	166	9371
161	207	0	82	172	9013
164	209	0	83	178	8671
164	209	0	83	183	8313
163	211	0	84	187	7989
167	213	0	83	187	7686
164	214	0	83	187	7441
162	215	0	84	187	7156
161	217	0	83	184	9467
162	219	0	81	178	9125
165	221	0	81	170	8785
165	221	0	80	164	8427
162	223	0	79	156	8141
171	224	0	80	149	7855
169	226	0	79	143	7556
166	228	0	79	138	9487
164	231	0	78	134	9129
162	232	0	76	129	8841
163	236	0	75	127	8499
166	238	0	74	125	8196
167	240	0	72	121	7914
163	240	0	69	116	7631
172	239	0	67	113	9412

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Method
Luminance ratios (between various surfaces)

Identify which pixels (cells) = 0

Matrix

West wall	Ceilling	East Wall	Floor	Window wall	Window
158	187	127	62	94	8712
158	188	126	63	100	8327
160	190	127	65	103	7989
163	190	128	68	107	7686
157	192	127	69	110	7400
158	193	129	69	113	7097
163	195	129	71	116	6815
164	196	130	72	118	9240
159	198	0	74	122	8841
158	199	0	74	126	8499
159	199	0	76	131	8155
164	199	0	77	136	7855
165	200	0	79	143	7570
164	202	0	80	151	7269
161	204	0	80	159	6986
160	205	0	81	166	9371
161	207	0	82	172	9013
164	209	0	83	178	8671
164	209	0	83	183	8313
163	211	0	84	187	7989
167	213	0	83	187	7686
164	214	0	83	187	7441
162	215	0	84	187	7156
161	217	0	83	184	9467
162	219	0	81	178	9125
165	221	0	81	170	8785
165	221	0	80	164	8427
162	223	0	79	156	8141
171	224	0	80	149	7855
169	226	0	79	143	7556
166	228	0	79	138	9487
164	231	0	78	134	9129
162	232	0	76	129	8841
163	236	0	75	127	8499
166	238	0	74	125	8196
167	240	0	72	121	7914
163	240	0	69	116	7631
172	239	0	67	113	9412

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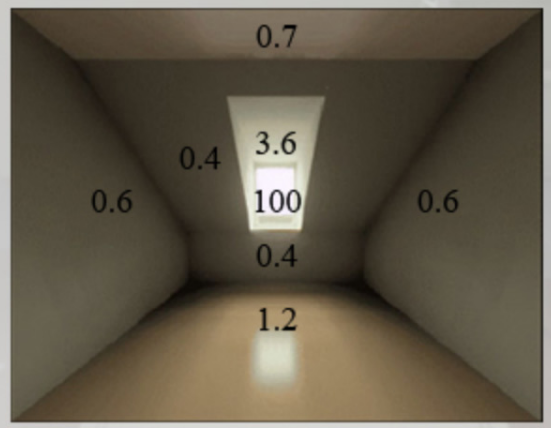
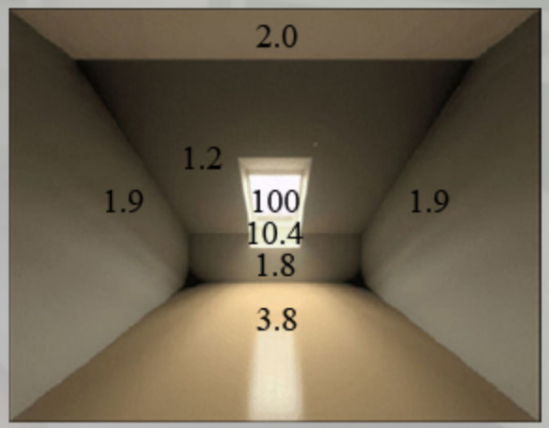
Method
Luminance ratios (between various surfaces)

	Window (sky) original data (cd/m²)	Window (sky)	Window (whole)	Window (ground)	Linings	Floor (front)	Floor (back)	Ceiling (front)	Ceiling (back)	West wall (front)	West wall (back)	East wall (front)	East wall (back)	North (back) wall	South wall	Slope south
Overcast																
Vertical	1944	100.0	92.3	7.3	-	1.9	1.3	1.7	1.3	1.6	1.4	1.6	1.4	1.3	0.8	-
Dormer	1891	100.0	90.9	7.5	3.6	1.2	0.9	0.7	0.8	0.6	0.6	0.6	0.6	0.9	0.4	0.4
Roof	1828	100.0	94.0	10.2	10.4	3.8	1.9	2.0	1.8	1.9	1.6	1.9	1.6	1.5	1.8	1.2

Vertical



Dormer



Roof

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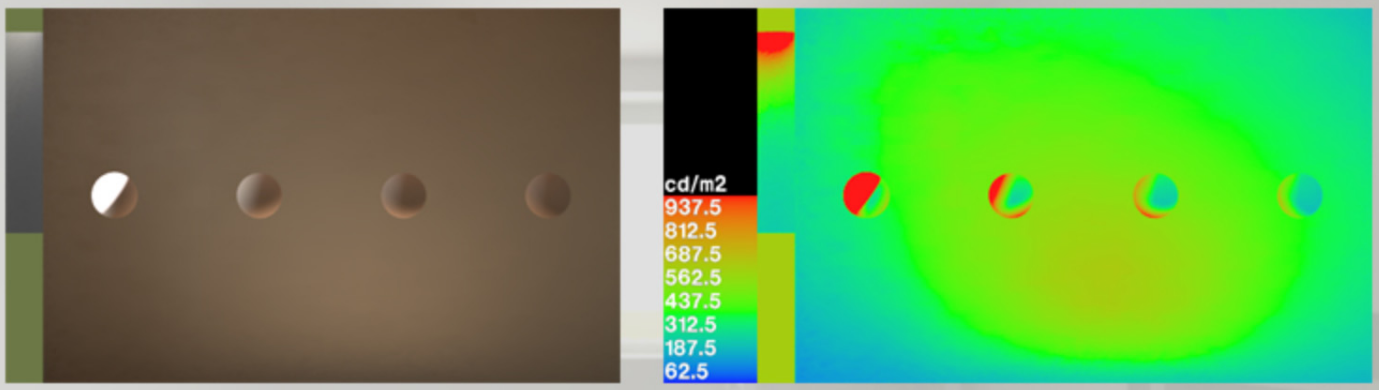
Extract from: Dubois M-C., Grau K., Traberg-Borup S. & Johnsen K. (2003). *Impact of three window configurations on daylight conditions: Simulations with Radiance*. Report By og Byg Documentation 047. Statens Byggeforskningsinstitut. Hørsholm, Denmark. 40 pages.

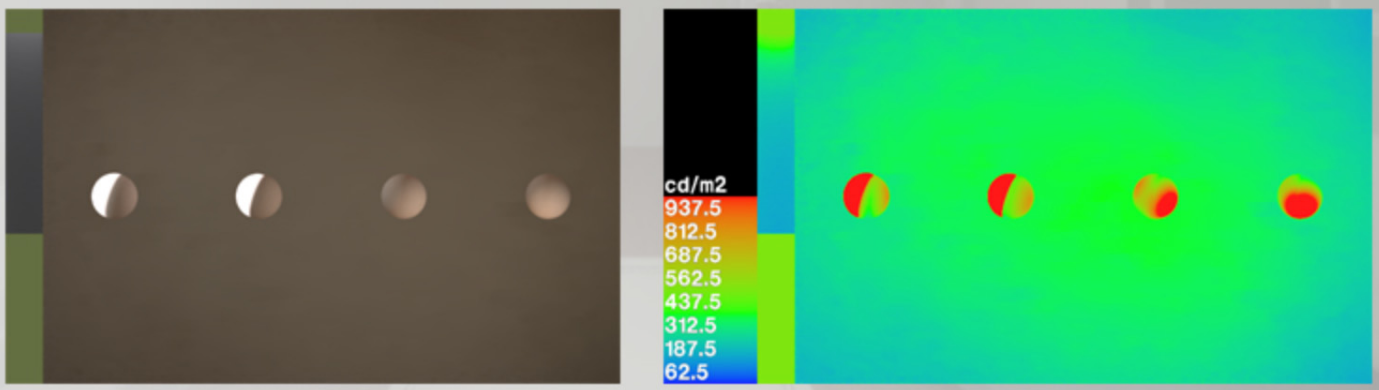
Method
Scale of shadow (Sophus Frandsen)

Section with spheres : Sunny, West, Jun 21

16:00 hours



18:00 hours



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Conclusion

Method based on performance indicators

- Sunlight patch (position, size, luminance)
- Luminance difference (LD) index
- Luminance ratios
- Scale of shadow

Allow to characterise light in space and identify the best design in terms of daylighting

Results of this study will be published after May 2005

marie-claude.dubois@arc.ulaval.ca

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