

Daylighting Design: A Daylight Glare Probability based analysis tool



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Overview

- Theoretical Background
- Method
- Tool demonstration: MetaForum
- Conclusions and Future development

- Theoretical Background
 - Daylighting Design
 - Glare analysis
- Method
- Tool demonstration
- Conclusions and
- Future development

Daylighting Design

• Availability of daylight for task performance



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Daylighting Design

- Availability of daylight for task performance
- Avoidance of visual discomfort



• Theoretical Background

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Glare analysis

Maximum Useful Daylight Illuminance

Daylight Glare Probability





A. Nabil, J. Mardaljevic. Useful daylight illuminance: A new paradigm for assessing daylight in buildings. Lighting Research and Technology 2005;37:41–59. J. Wienold, J. Christoffersen. Towards a new daylight glare rating: Proceedings of Lux Europa 2005 - Lumie`re pour l'homme, Sep 19–21. Berlin: 2005.

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% of Time

• Theoretical Background

- Daylighting Design
- Glare analysis
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• Conclusions and

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% of Time

DGP

Brightness and contrast

• Theoretical Background

- Daylighting Design
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% of Time

DGP

Brightness and contrast

- Theoretical Background
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 - Grid
 - % of Time
 - Result presentation
 - Tool
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2.7m 0 0 0 0 0.5m 0 0 0 0 0 0 0 0 3.6m 1.1m 0 0 0 0 0 0 1.2m 0 5.4m

D. van Dijk. Reference office for thermal, solar and lighting calculations; Internal report for IEA SHC Task 27.TNO Building and Construction Research, Department of Sustainable Energy and Buildings, Delft, Netherlands: 2001.

- Theoretical Background
- Method
 - <u>Grid</u>
 - % of Time
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Use DGP in grid- and time-based approach Grid



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Use DGP in grid- and time-based approach Grid





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Use DGP in grid- and time-based approach

Time



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Result Presentation

DGP	Sensor I	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6
8:00	0.309187	0.277502	0.260626	0.248367	0.246052	0.244021
9:00	0.356699	0.302541	0.280247	0.261182	0.25379	0.244906
10:00	0.367384	0.335964	0.296979	0.272847	0.259299	0.249434
11:00	0.379443	0.329023	0.318449	0.284569	0.262797	0.253094
I 2:00	0.390982	0.332575	0.311157	0.291873	0.265985	0.255518
13:00	0.397619	0.335777	0.311035	0.290291	0.266474	0.256383
I 4:00	0.421127	0.342045	0.311948	0.288458	0.263927	0.254528
15:00	0.45065	0.360717	0.31473	0.286954	0.260403	0.252871
16:00	0.453683	0.395214	0.330749	0.289438	0.264874	0.253755
17:00	0.448965	0.399359	0.36349	0.309666	0.272497	0.256924
18:00	0.439377	0.39807	0.367441	0.336662	0.29863	0.266267



- Theoretical Background
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100% 100% 100% 100%

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Result Presentation

10%	38%	38%	10%	43%
48%	57%	62%	48%	81%
81%	81%	81%	76%	100%
				40000
100%	100%	100%	100%	100%
100%	100%	100%	100%	100%
100%	100%	100%	100%	100%
100% 100%	100% 100%	100% 100%	100% 100%	100% 100%
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43%

81% 100%

100%

100%

100%

100%

100%

100%

10% 48%

81%

100%

100%

100%

100%

100% 100%

- Tool
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Resu

					Daylight glare probability										DGP :	5	0.		
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													F						
							43%	10%	38%	38%	10%	43%	10	0%	100%	100%	100%	100%	100%
							81%	48%	57%	62%	48%	81%	10	0%	100%	100%	100%	100%	100%
							100%	81%	81%	81%	76%	100%	10	0%	100%	100%	100%	100%	100%
							100%	100%	100%	100%	100%	100%	10	0%	100%	100%	100%	100%	100%
							100%	100%	100%	100%	100%	100%	10	0%	100%	100%	100%	100%	100%
							100%	100%	100%	100%	100%	100%	10	0%	100%	100%	100%	100%	100%
38	8%	10%	43%				100%	100%	100%	100%	100%	100%	10	0%	100%	100%	100%	100%	100%
62	2%	48%	81%				100%	100%	100%	100%	100%	100%	10	0%	100%	100%	100%	100%	100%
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Tool for Windows

- Radiance for Windows
- DAYSIM
 - Evalglare

Daylig	nt Glare Proba	ibility Tool							2/3
Welcome	File selection	Location	Date	Viewpoints	Calculate	Results			
DGP-Tool	v. 1.00			Eindhe	oven, Septe	mber 201	2		
Welcome									
This is the The tool u The DGP	DGP-Tool, for ses the Dayligh tool calculates t	calculating th t Glare Proba the glare pro	ne glare ability im bability f	probability for plemented in t or a percenta	design of da he Evalglare ge of time ov	aylit space e commar ver a grid	e. nd. placed	l in the	espace
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MetaForum

- Technical University of Eindhoven
 - Flex-Desks for students



Ector Hoogstad Architects

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C.E. Laudij

Master student Architecture & Building Physics

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*.Rad file Including material information

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Grid-points file

X[space]Y[space]Z

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View-directions file

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Calculation

Note

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0.4	0.8	1	1	1	1	1	0.9	1	1	1	1
0.5	0.8	1	1	1	1	1	1	1	0.9	0.9	1
0.5	1	1	1	1	1	1	1	1	1	1	0.9
0.5	1	1	1	1	1	1	1	1	1	1	0.9
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0.	5 1	1	1	1	1	1	0.9	1	1	1	1
0.	4 0.7	7 1	1	1	1	1	0.9	1	1	1	1
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	1	1	1	1	0.9	1	1	1	1	1	1	0.5
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	0.9	1	1	1	1	1	1	1	1	1	1	0.5
	0.0	1	1	1	1	1	1	1	1	1	1	0.5
	0.5											
	0.9	1	1	1	1	1	1	1	1	1	1	0.3
	0.9	1	1	1	1	1	1	1	1	1	1	0.3
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	0.9 0.8 0.7 0.8	1 0.7 0.7 0.7	1 0.7 0.6 0.7	1 0.7 0.7 0.7	1 0.8 0.7 0.7	1 0.9 0.8 0.8	1 1 1 0.7	1 1 1 1	1 1 1	1 0.9 0.9 1	1 1 1	0.3 0.9 0.9 0.9
•	0.9 0.9 0.7 0.8 0.6	1 0.7 0.7 0.7 0.7	1 0.7 0.6 0.7 0.7	1 0.7 0.7 0.7 0.7	1 0.8 0.7 0.7 0.7	1 0.9 0.8 0.8	1 1 0.7 0.6	1 1 1 0.9	1 1 1 1 1	1 0.9 0.9 1 1	1 1 1 0.9	0.3 0.9 0.9 0.9
•	0.9 0.8 0.7 0.8 0.6 0.5	1 0.7 0.7 0.7 0.7 0.7	1 0.7 0.6 0.7 0.7 0.7	1 0.7 0.7 0.7 0.7 0.7	1 0.8 0.7 0.7 0.7 0.6	1 0.9 0.8 0.8 0.6 0.5	1 1 0.7 0.6 0.5	1 1 1 0.9 0.7	1 1 1 1 1	1 0.9 1 1 1	1 1 1 0.9 1	0.3 0.9 0.9 1 1
	0.9 0.9 0.7 0.8 0.6 0.5 0.4	1 0.7 0.7 0.7 0.7 0.6 0.5	1 0.7 0.6 0.7 0.7 0.7 0.7	1 0.7 0.7 0.7 0.7 0.7	1 0.8 0.7 0.7 0.7 0.6 0.4	1 0.9 0.8 0.6 0.5 0.4	1 1 0.7 0.6 0.5 0.4	1 1 0.9 0.7 0.5	1 1 1 1 1 1	1 0.9 1 1 1 1	1 1 1 0.9 1 1	0.9 0.9 0.9 1 1 0.8

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	1	1	1	1	0.9	1	1	1	1	1	1	0.5
	1	1	1	1	0.9	1	1	1	1	1	0.7	0.4
^	1	1	1	1	0.9	1	1	1	1	1	0.8	0.4
	1	0.9	0.9	1	1	1	1	1	1	1	0.8	0.5
	0.9	1	1	1	1	1	1	1	1	1	1	0.5
	0.9	1	1	1	1	1	1	1	1	1	1	0.5
	0.9	1	1	1	1	1	1	1	1	1	1	0.3
		0.7	0.7	0.7								
	0.8	0.7	0.7	0.7	0.8	0.9	1	1	1	0.9	1	0.9
	0.7	0.7	0.6	0.7	0.7	0.8	1	1	1	0.9	1	0.9
	0.8	0.7	0.7	0.7	0.7	0.8	0.7	1	1	1	1	0.9
	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.9	1	1	0.9	1
	0.5	0.6	0.7	0.7	0.6	0.5	0.5	0.7	1	1	1	1
	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.5	1	1	1	0.8
	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.6	0.3	0.2	0.2
									0.7			0.1
	0.5	0.4	0.5	0.9	1	1	1	1	0.7	0.3	0.2	0.1
	0.5	0.5	0.5	0.8	1	1	1	1	0.9	0.3	0.3	0.1
	0.6	1	0.9	1	0.5	0.6	1	1	0.9	0.5	0.4	0.1
	0.4	0.5	0.5	0.5	0.4	0.5	0.5	0.9	1	0.4	0.3	0.1
	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.9	0.5	0.2	0.2	0.1
	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1
	0	0	0	0	0	0	0	0	0	0	0	0

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0.5	1	1	1	1	1	1	0.9	1	1	1	1
0.4	0.7	1	1	1	1	1	0.9	1	1	1	1
0.4	0.8	1	1	1	1	1	0.9	1	1	1	1
0.5	0.8	1	1	1	1	1	1	1	0.9	0.9	1
0.5	1	1	1	1	1	1	1	1	1	1	0.9
0.5	1	1	1	1	1	1	1	1	1	1	0.9
0.3	1	1	1	1	1	1	1	1	1	1	0.9
0.9	1	0.9	1	1	1	0.9	0.8	0.7	0.7	0.7	0.8
0.9	1	0.9	1	1	1	0.8	0.7	0.7	0.6	0.7	0.7
0.9	1	1	1	1	0.7	0.8	0.7	0.7	0.7	0.7	0.8
1	0.9	1	1	0.9	0.6	0.6	0.7	0.7	0.7	0.7	0.6
1	1	1	1	0.7	0.5	0.5	0.6	0.7	0.7	0.6	0.5
0.8	1	1	1	0.5	0.4	0.4	0.4	0.5	0.5	0.5	0.4
0.2	0.2	0.3	0.6	0.4	0.2	0.2	0.2	0.2	0.2	0.2	0.2
0.1	0.2	0.3	0.7	1	1	1	1	0.9	0.5	0.4	0.5
0.1	0.3	0.3	0.9	1	1	1	1	0.8	0.5	0.5	0.5
0.1	0.4	0.5	0.9	1	1	0.6	0.5	1	0.9	1	0.6
0.1	0.3	0.4	1	0.9	0.5	0.5	0.4	0.5	0.5	0.5	0.4
0.1	0.2	0.2	0.5	0.9	0.4	0.4	0.3	0.3	0.3	0.3	0.2
0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
0	0	0	0	0	0	0	0	0	0	0	0
~	0.1		0.2	0.5							
0	0.1	0.2	0.3	0.5	0.8	0.9	1	1	1	0.8	0.8
0	0.1	0.2	0.3	0.5	0.8	0.9	1	1	1	0.8	0.8
0	0.1	0.2	0.4	0.6	0.9	0.9	1	1	1	0.9	0.8
0.1	0.2	0.3	0.5	0.6	0.9	0.8	0.9	0.9	0.9	0.9	0.9
0	0.1	0.3	0.5	0.6	0.8	0.8	0.8	0.7	0.8	0.8	0.8
0	0.1	0.2	0.3	0.5	0.8	0.8	0.5	0.5	0.5	0.5	0.6
0	0.1	0.1	0.2	0.2	0.4	0.3	0.3	0.3	0.3	0.3	0.3

Daylighting Design: A Daylight Glare Probability based analysis tool

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0 0.1

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Next...

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Interior design?





Conclusions and future development

Conclusions

- Theoretical Background
- Method
- Tool demonstration
- <u>Conclusions and</u> <u>Future development</u>
- Easy applicable glare analysis tool for Microsoft Windows
- Easy production of false-colour floor plans
- The results differ from UDI_{max} results
- Approach includes view direction

Future development

- Theoretical Background
- Method
- Tool demonstration
- <u>Conclusions and</u> <u>Future development</u>
- Tool is in development
- Time consuming
- Small number of test cases

The End

Questions?

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