My Portfolio

I am a second-term master's student in Building Science Engineering, and this portfolio is for the course titled 'Lighting'. This collection of work reflects my comprehensive understanding and application of lighting principles in building design. It includes various assignments and studies that demonstrate my ability to analyze, design, and optimize lighting systems to enhance energy efficiency, visual comfort, and overall building performance. This portfolio represents my dedication to advancing sustainable and innovative lighting solutions in the field of building science.

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Guide: Mr. Amirfarbod Shahverdi
STUDENT: Amirhossein Bahrami

My Vision

In an era where energy consumption significantly impacts our environment, I envision a future where we prioritize sustainable practices to reduce our ecological footprint. By using less energy, we can contribute to a healthier planet, mitigating the adverse effects of climate change and conserving natural resources. This approach is not just a necessity but a responsibility towards creating a better environment for future generations. I am committed to developing innovative solutions that optimize energy usage in buildings, ensuring that our actions today lead to a sustainable and thriving Earth.

Equally important is the well-being of human beings. My vision emphasizes creating environments that prioritize human comfort and happiness. By designing spaces that cater to people's needs and promote well-being, we can foster a society where individuals are more productive, satisfied, and mentally at peace. Happier individuals contribute to a more efficient and harmonious society, ultimately leading to a better quality of life for all. Sustainability, in my view, encompasses both environmental stewardship and the enhancement of human life, creating a balanced and thriving world for everyone.

Content

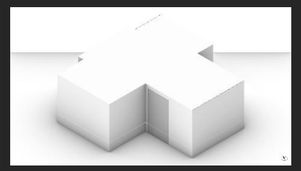
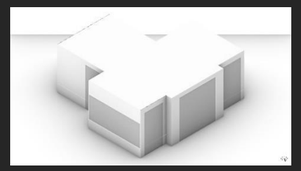
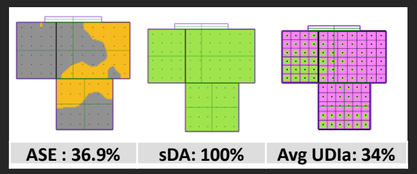
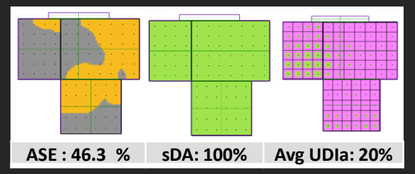
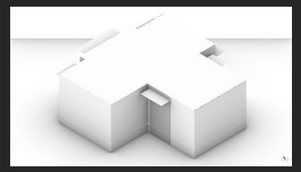
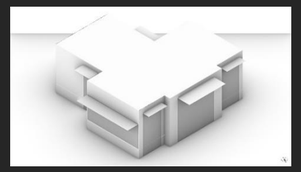
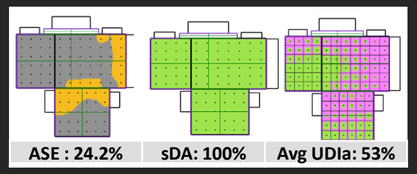
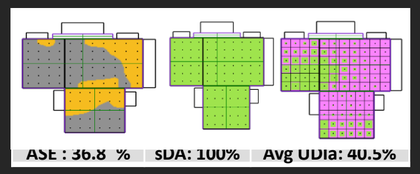
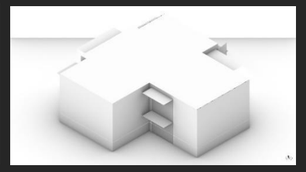
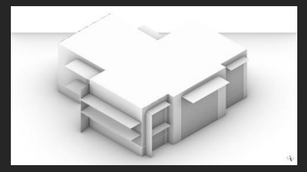
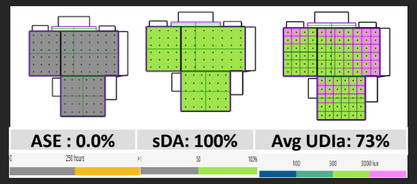
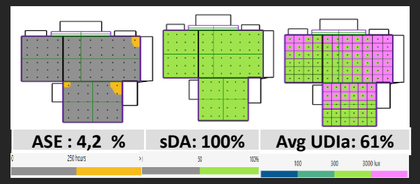
Abstract
Enhancing comfort in interior spaces by increasing natural light is a crucial aspect of energy optimization, especially in commercial buildings. With rising energy consumption, the need for multi-objective optimization and efforts to reduce consumption, particularly in developing countries, is growing. This has led architects to design buildings that maximize the use of renewable energy, optimizing the use of energy and sunlight. Utilizing natural sunlight during the day not only creates a favorable environment for users but also reduces energy consumption for heating and cooling. Therefore, controlling the amount of light entering a space is a significant factor in improving energy efficiency in buildings. This report examines the performance of design factors such as materials, window dimensions, and shading devices, and their impact on daylight components and radiation absorption as influential elements on the quality of interior spaces, using a café in Ramsar and Yazd as case studies.

1. Introduction

Daylight plays a vital role in the quality of interior spaces. It not only provides the necessary illumination for daily activities but also significantly impacts human physical and mental health, the aesthetics of spaces, and energy consumption. Various factors such as building orientation, the dimensions and types of windows, and shading elements can influence the amount of light entering a space. Analyzing the light levels in any space with different lighting indices helps architects understand the conditions for light comfort in the space and aids in optimizing the design.

Daylight Efficiency Optimization

grasshopper ClimateStudio Rhinoceros

	West-southern	East-northern	Ramsar	Yazd
Block 1				
Block 2				
Block 3				

2. Research Methodology

2.1 Study Cities The cities studied in this report are Yazd and Ramsar. Yazd, located in a hot and dry desert climate, experiences low rainfall, hot and dry summers, and cold and dry winters, with direct and diffuse radiation amounts of 5500 and 2500 watt-hours per square meter, respectively. Ramsar, located in the Mazandaran province in northern Iran, has a moderate Caspian climate, with global horizontal radiation, direct radiation, and diffuse radiation amounts of 488, 788, and 301 watt-hours per square meter, respectively. Compared to Yazd, Ramsar receives less radiation due to the cloudy sky, which averages 70% annually. A passive strategy in this region involves using large south-facing windows to capture all the radiation in winter and deep shading devices to prevent radiation in summer.

2.2 Study Site The study site is a café with a north-facing entrance and three functional areas: a kitchen, a laptop working space, and a main café area. The café is bordered by buildings on the northeast, northwest, and southwest sides.

3. Research Data

Sensors were placed at table height in the kitchen and computer area, and at seated head height in the café area, with a 60 cm distance between sensors. Cloudy skies were considered for Ramsar and clear skies for Yazd.

3.1 Block 2 Adjustments Daylight entry was increased by changing the entrance door to glass and adding a window above it. Vertical, narrow windows were added to the northeast and southwest walls to enhance central café lighting without causing screen glare.

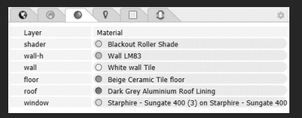
3.2 Block 3 Adjustments Shading devices were added to kitchen and entrance windows. Vertical windows around the computer area were moved closer to improve central lighting. Materials for the southeast computer window and west kitchen window were changed, and the number of louvers was increased for uniform light distribution.

3.3 Adjustments for Ramsar Climate Vertical eastern windows were used to increase light depth and uniformity while reducing glare. The number of louvers on the northern window was increased, and materials were changed to less reflective ones.

3.4 Adjustments for Yazd Climate The number of louvers was increased, and their angle adjusted to control summer light entry.

3.5 Block 3 Adjustments for Ramsar Horizontal shading devices were added to address excessive light and heat. Further adjustments included increasing shading depth, adding louvers, and adding vertical shading to openings.

Plan and materials



when architect helps marketing

Objective

This report investigates glare indices on the east wall of a coffee shop. The objective of this study is to design a suitable double-skin façade with a distance of 40 cm from the translucent wall for a coffee shop space with dimensions of 12 m x 5 m and a height of 4.5 m. Evaluation of SDA and ASE levels and measurement of glare in two directions facing the translucent wall and back to it using the DGP index.

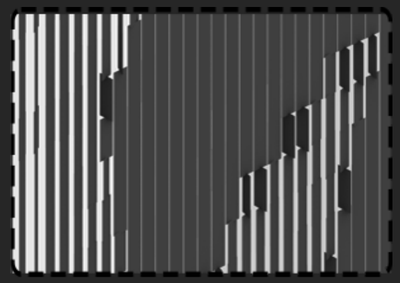
Design Approach

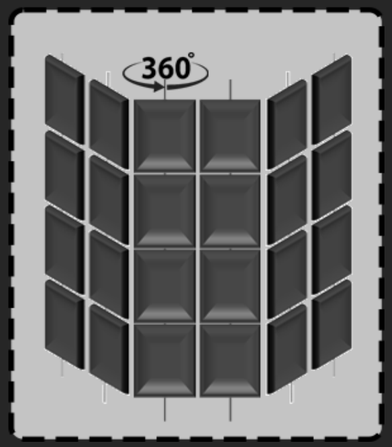
The façade of this structure is designed parametrically and consists of two separate skins. Between these two skins, openings are provided to allow natural light to enter the interior space.

The window-to-wall ratio (WWR) is considered to be 80%. Sensors are also installed at a height of 76 cm from the ground level and at a distance of 60 cm from each other.

Starbucks Cafe

Layer	Objects	Material		R.vis	T.vis
wall	4	Matte White wall		80.7 %	0.0 %
ceiling	1	White Ceiling Panels		84.9 %	0.0 %
glazing	1	Clear - Clear		14.9 %	77.4 %
floor	1	Brown Wooden floor		4.9 %	0.0 %
shading	68800	Dupont Midnight Black 120		0.3 %	0.0 %
neighbour	6	Wall LM83		50.0 %	0.0 %



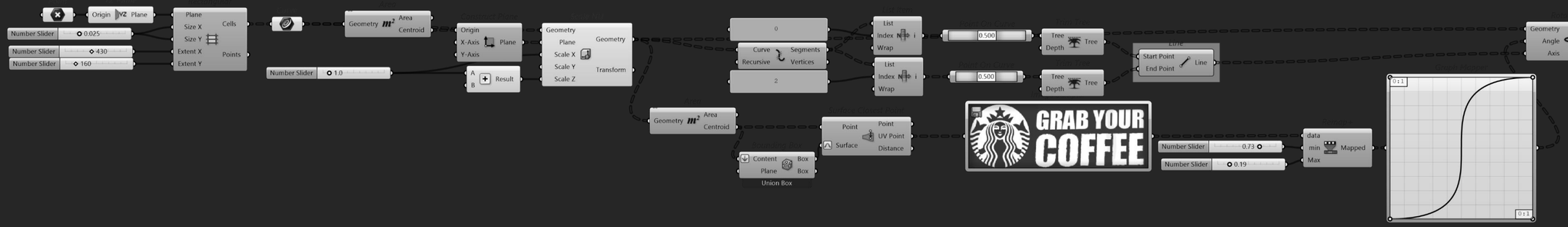


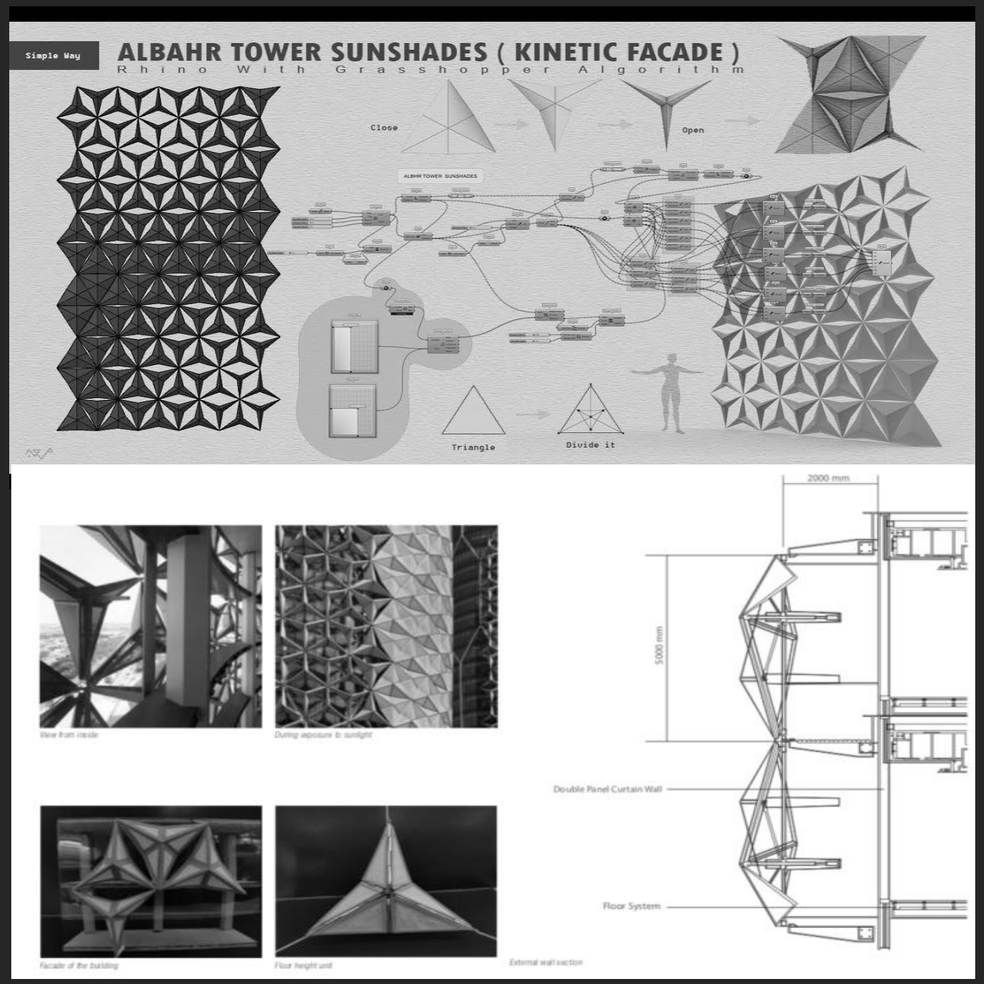
			Summer solstice				Winter solstice				
			DGP		EV		DGP		EV		
			FRONT	BACK	FRONT	BACK	FRONT	BACK	FRONT	BACK	
			1	0.19	36938	518	1	0.539	25079	6463	MAX
SDG	ASE	SDA	0.096	0.04	178	119	0.029	0.019	101	82	MIN
1.9%	0.6%	83.1%									RESULT

The openings are designed to be parametrically changeable in number and size. This has allowed us to achieve the optimal level of glare during the design process.

Results

The results of the study show that the proposed double-skin façade can effectively reduce glare levels in the coffee shop space. The DGP index was found to be below the recommended threshold of 25 in both directions, facing the translucent wall and back to it. This indicates that the proposed façade provides a comfortable visual environment for occupants.





Introduction

The aim of this exercise is to design a dynamic facade for a classroom space, inspired by the Al Bahar Towers in Abu Dhabi. The facade design includes four control scenarios to optimize lighting conditions, minimize glare, and reduce energy consumption from artificial lighting.

Objectives

1.Optimize Natural Lighting: Ensure adequate natural lighting for all workspaces in the classroom.

2.Minimize Glare: Reduce glare to improve comfort and productivity.

3.Energy Efficiency: Decrease reliance on artificial lighting to save energy.

4.Dynamic Facade Control: Implement a responsive facade system with multiple configurations for effective daylight management.

Process

The exercise involves several steps to design and test the dynamic facade:

Step 1: Sensor Placement

•**Four Sensors**: Two sensors are placed near the windows on desks, and two are placed at the back of the classroom on desks.

•**Height**: Sensors are installed at a height of 0.76 meters.

Step 2: Initial Facade Design

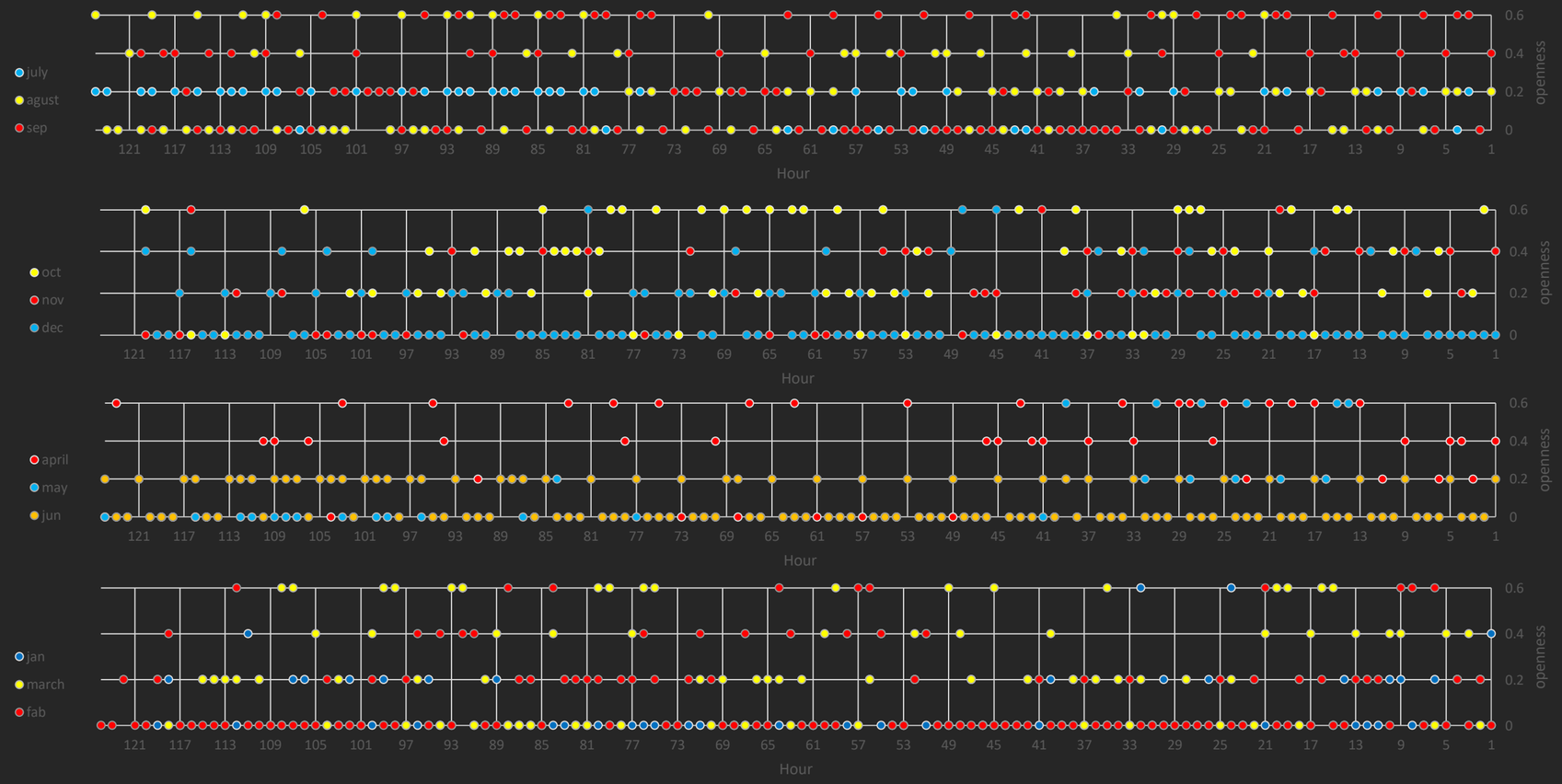
•**One-Piece Shading Device**: A single, uniform shading device is used for the entire facade.

•**Control Program**: The shading device is controlled throughout the year at 8:00, 10:00, 12:00, and 14:00 hours to ensure optimal lighting conditions.

Dynamic shader
(visual effects)

grasshopper Rhinoceros

One-Piece Shading Device



Step 3: Two-Piece Horizontal Shading Device

•**Upper and Lower Sections**: The facade is divided into upper and lower sections, each controlled independently.

•**Control Program**: Adjustments are made to ensure each section provides optimal lighting conditions without excessive glare.

Step 4: Two-Piece Vertical Shading Device

•**Left and Right Sections**: The facade is divided into left and right sections, each controlled independently.

•**Control Program**: Each section is adjusted to maintain optimal lighting and minimize glare.

Results

The results are presented for different facade configurations and control scenarios at 8:00, 10:00, 12:00, and 14:00 hours during both solstices and one equinox:

One-Piece Shading Device

•**Lighting Levels**: Ensures adequate natural light but may lead to uneven lighting distribution.

•**Glare Control**: Effective in reducing glare but not optimal in all conditions.

Two-Piece Horizontal Shading Device

•**Upper Section**: Provides better control for high sun angles.

•**Lower Section**: Ensures sufficient light for lower sun angles.

•**Glare Control**: Improved compared to one-piece design.

Two-Piece Vertical Shading Device

•**Left Section**: Adjusts for early morning and late afternoon sun.

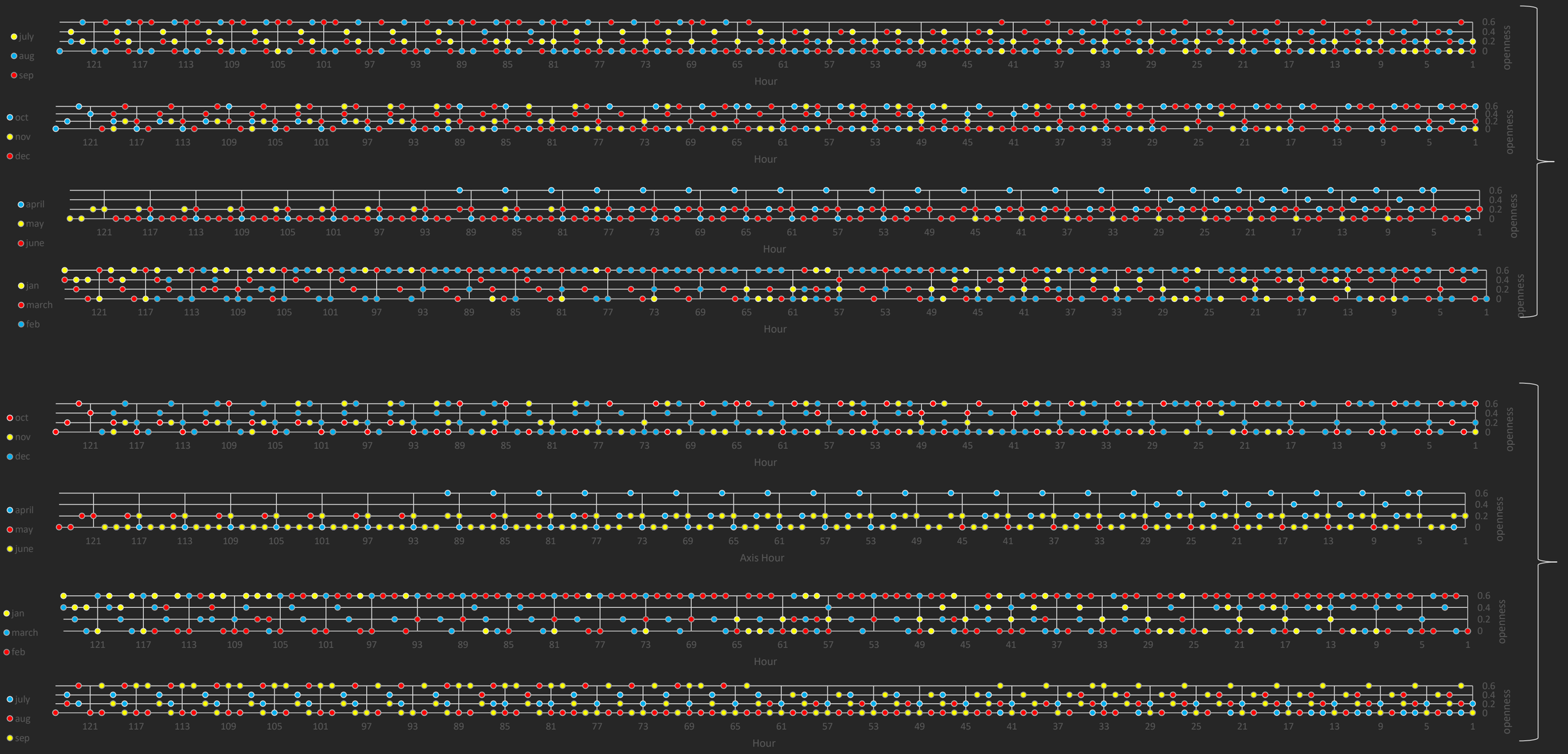
•**Right Section**: Optimizes mid-day lighting conditions.

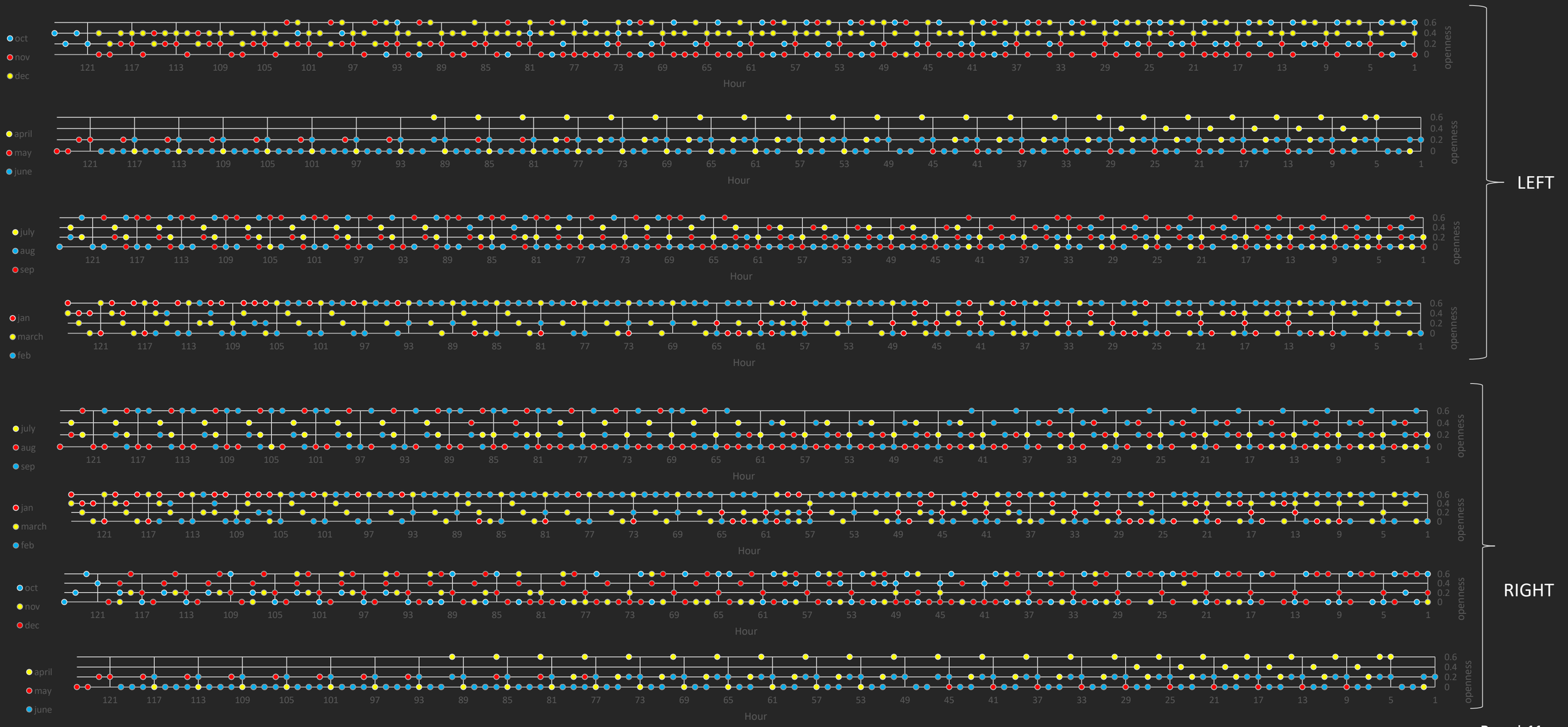
•**Glare Control**: Offers the best glare reduction and lighting optimization.

Conclusion

The study demonstrates that a dynamic facade with independently controlled sections can significantly enhance lighting conditions and reduce glare in a classroom setting. The two-piece vertical shading device configuration provides the best results in balancing natural light and minimizing glare. The use of sensors and simulation tools is crucial in designing an effective control system for dynamic facades.

Two-Piece Horizontal Shading Device

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121 117 113 109 105 101 97 93 89 85 81 77 73 69 65 61 57 53 49 45 41 37 33 29 25 21 17 13 9 5 1
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0
openness
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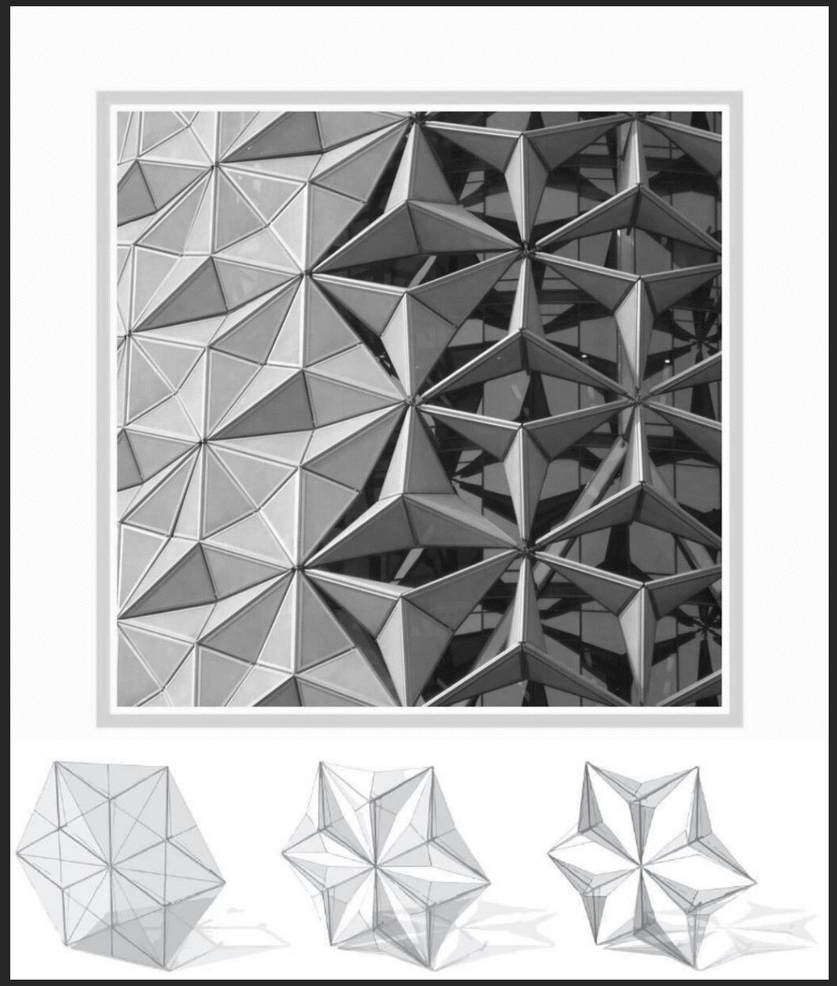


Introduction
This study evaluates the impact of dynamic facades on non-visual indices and exterior view quality in a classroom inspired by the Al Bahar Towers in Abu Dhabi. The facade configurations are assessed during specific hours (8 AM and 2 PM) on solstice and equinox days, with the goal of optimizing lighting, glare control, and energy efficiency.

Objectives

1.Optimize Non-Visual Lighting Conditions: Enhance non-visual indices such as melatonin production by utilizing specific wavelengths.

2.Improve Exterior View Quality: Ensure a high quality of exterior views while maintaining optimal interior lighting conditions.

3.Dynamic Facade Control: Implement and assess different dynamic facade configurations to achieve the best balance of lighting, glare control, and view quality.

Step 1: Baseline Assessment without Shading

•**Two Configurations**: The classroom's light-receiving facade is assessed facing both south and north.

•**Times**: Evaluations are conducted at 8 AM and 2 PM during the winter solstice, summer solstice, and autumn equinox.

•**Non-Visual Indices**: Focus on the photopic (visual) and melanopic (non-visual) light ratios to understand their effects on circadian rhythms and alertness.

Step 2: Dynamic Facade Designs

•**One-Piece Shading Device**: Uniform shading for the entire facade.

•**Two-Piece Horizontal Shading Device**: Upper and lower sections controlled independently.

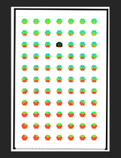
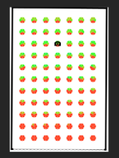
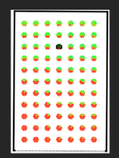
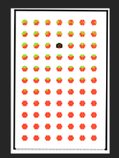
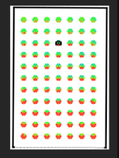
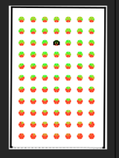
•**Two-Piece Vertical Shading Device**: Left and right sections controlled independently.

•**South-Facing Configuration**: Impact of each shading configuration on non-visual indices is assessed during the specified hours.

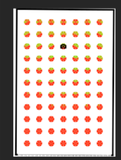
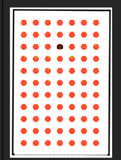
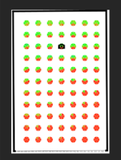
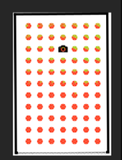
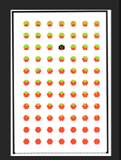
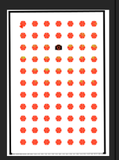
Dynamic shader
(non-visual effects)

grasshopper ClimateStudio Rhinoceros ALFA

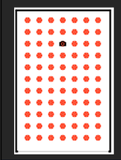
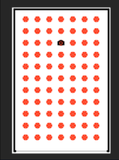
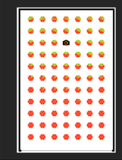
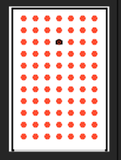
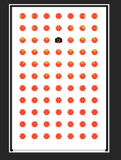
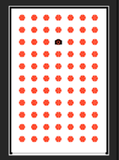
Southern window 2sections vertical

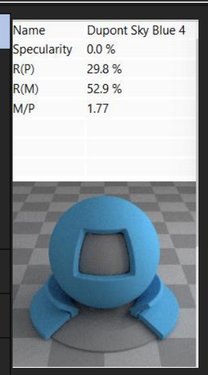
September		December		June		
						
8am	14pm	8am	14pm	8am	14pm	
1.69	1.77	1.21	1.53	1.68	1.73	M/P
849	1737	833	2447	926	1418	Melanopic Lux (avg)
545	1170	797	1848	600	891	Photopic Lux (avg)

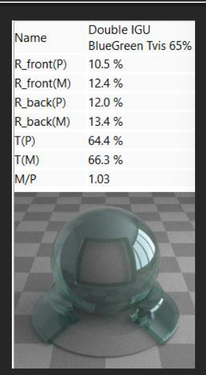
Southern window 1section shader

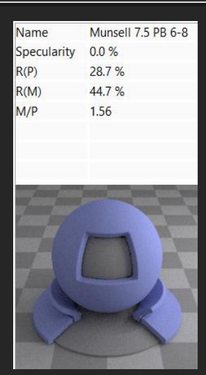
September		December		June		
						
8am	14pm	8am	14pm	8am	14pm	
1.67	1.79	1.22	1.53	1.68	1.74	M/P
1255	1737	872	2339	977	1487	Melanopic Lux (avg)
822	1056	827	2073	631	928	Photopic Lux (avg)

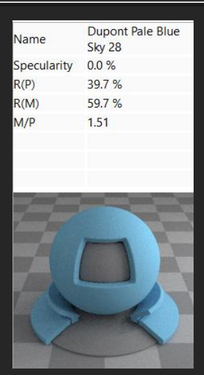
Southern window

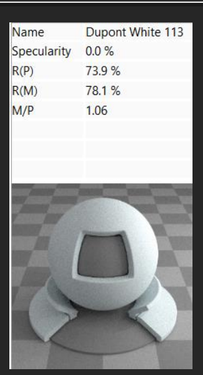
September		December		June		
						
8am	14pm	8am	14pm	8am	14pm	
1.42	1.50	1.11	1.46	1.63	1.66	M/P
1582	2790	1838	7501	1491	2218	Melanopic Lux (avg)
1117	1855	1696	6465	955	1454	Photopic Lux (avg)





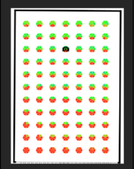
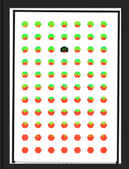
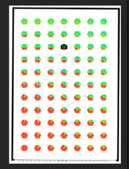
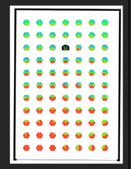
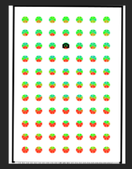
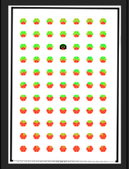




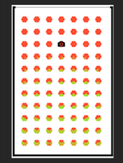
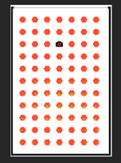
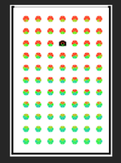
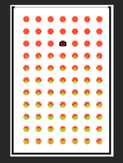
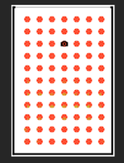
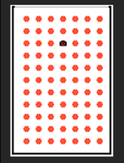


SHADER WINDOW FLOOR ROOF WALL

Southern window 2sections horizontal

September		December		June		
						
8am	14pm	8am	14pm	8am	14pm	
1.67	1.76	1.21	1.5	1.68	1.73	M/P
1278	1585	842	937	894	1380	Melanopic Lux (avg)
876	1084	821	783	578	864	Photopic Lux (avg)

Northern window

September		December		June		
						
8am	14pm	8am	14pm	8am	14pm	
1.63	1.64	1.59	1.67	1.61	1.66	M/P
1227	1518	497	1146	1724	1833	Melanopic Lux (avg)
825	986	342	745	1172	1203	Photopic Lux (avg)

Results

Baseline (Without Shading)

•**South-Facing Facade**: High light levels at 8 AM and 2 PM, leading to potential glare and excessive brightness.

•**North-Facing Facade**: Lower light levels, more consistent but less effective for circadian regulation.

Dynamic Facade Configurations (South-Facing)

•**One-Piece Shading Device**:

- **8 AM**: Effective at reducing glare but may not provide sufficient melanopic light.
- **2 PM**: Adequate lighting with some glare reduction.

•**Two-Piece Horizontal Shading Device**:

- **8 AM and 2 PM**: Better control of light distribution, improved balance of photopic and melanopic ratios.

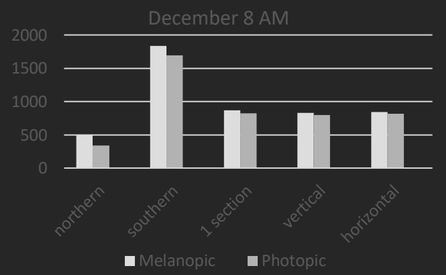
•**Two-Piece Vertical Shading Device**:

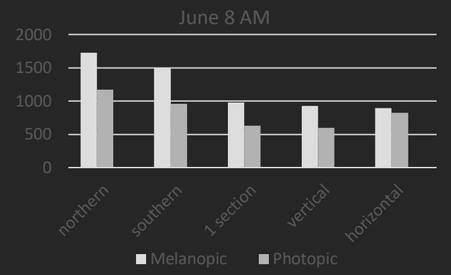
- **8 AM**: Optimal light control, especially effective for early morning sun.
- **2 PM**: Maintains good light levels with minimized glare.

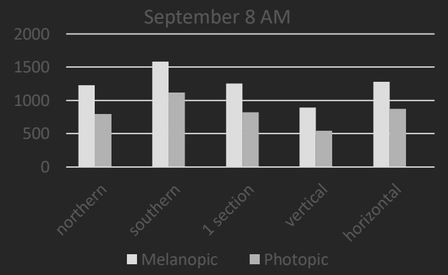
Conclusion

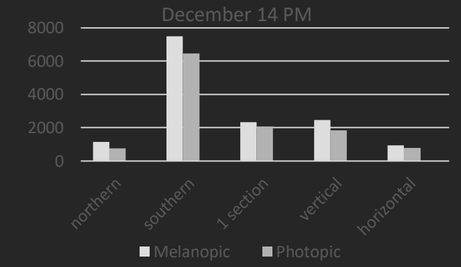
The study demonstrates that dynamic facades significantly improve non-visual indices and exterior view quality. The two-piece vertical shading device is the most effective in balancing light control, glare reduction, and maintaining high melanopic to photopic light ratios. This design can enhance learning environments by promoting better circadian regulation and reducing discomfort from glare.

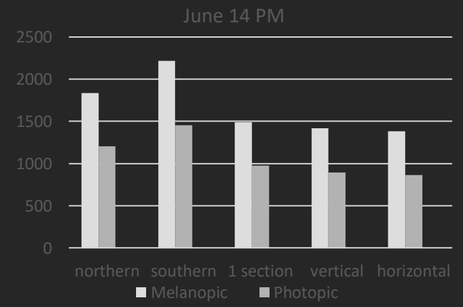
Visual comfort

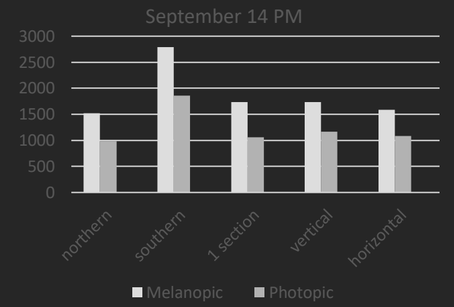




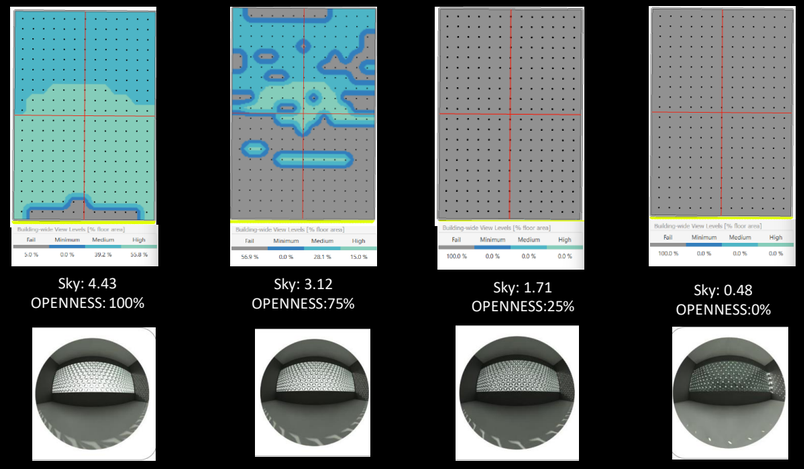


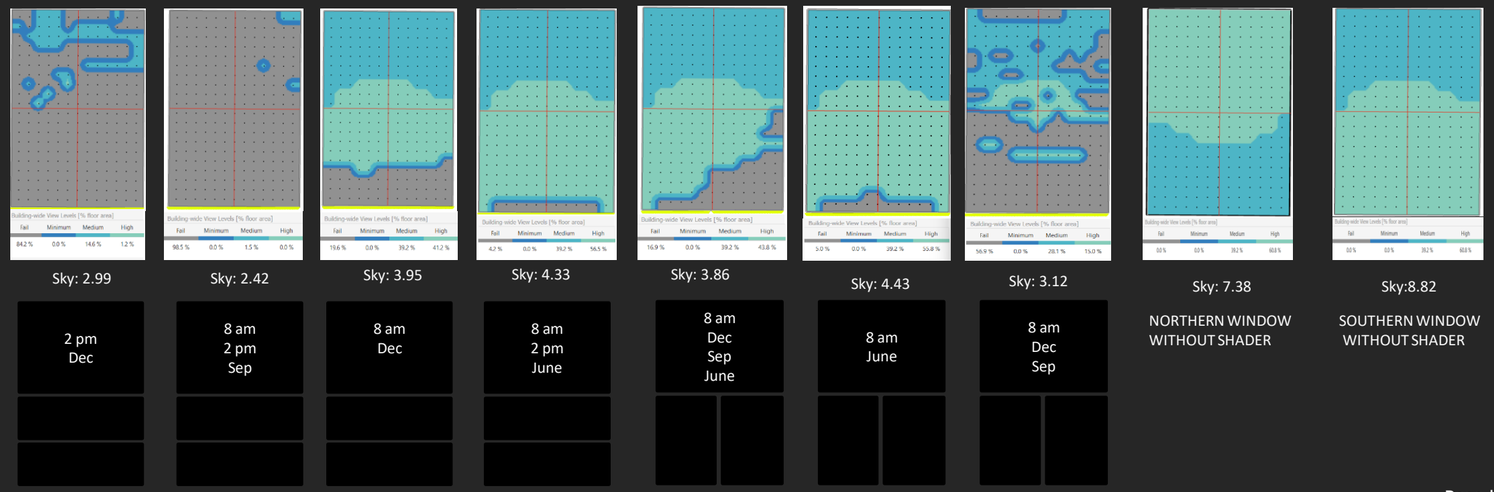


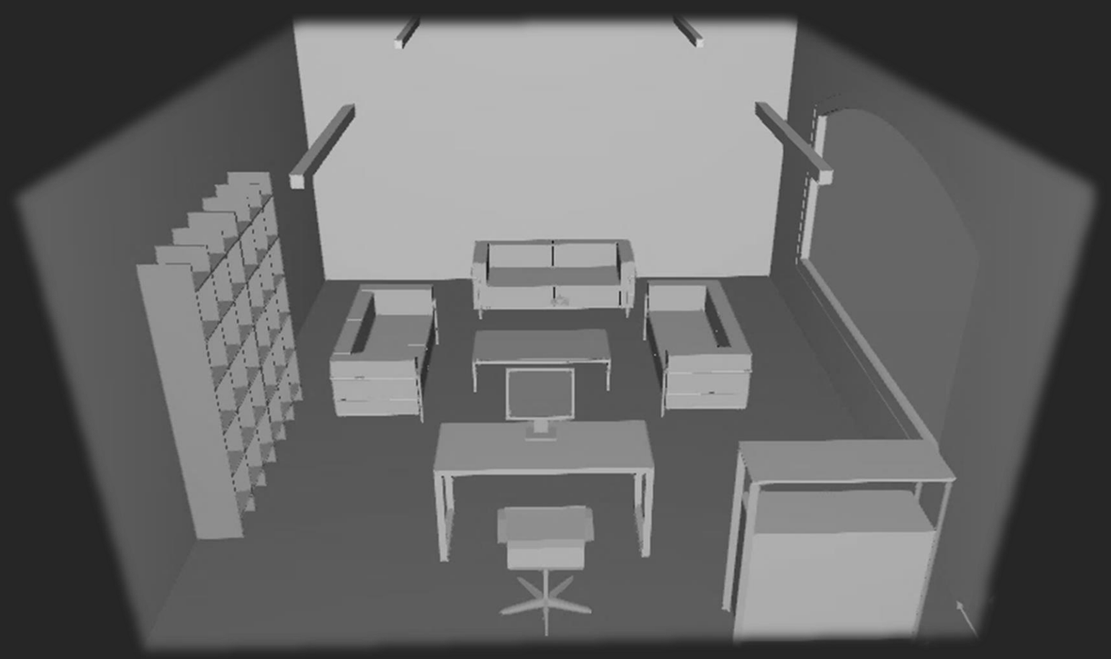




Summary
In educational settings, optimizing lighting conditions with dynamic facades can enhance student well-being and performance. The use of specific colors and materials that increase melanopic light can further improve cognitive functions. The methodology and findings from this study can be applied to similar projects to create more effective and comfortable learning environments.







area	30m²
location	Arak

Introduction
This exercise aims to design an artificial lighting system tailored to the space's needs, user comfort, and optimal energy consumption. The selected space includes specific features such as a work desk with a monitor and a vertical element (e.g., bookshelf or wall-mounted picture). The lighting design is modeled using DIALux software, and non-visual comfort is assessed using Alpha software.

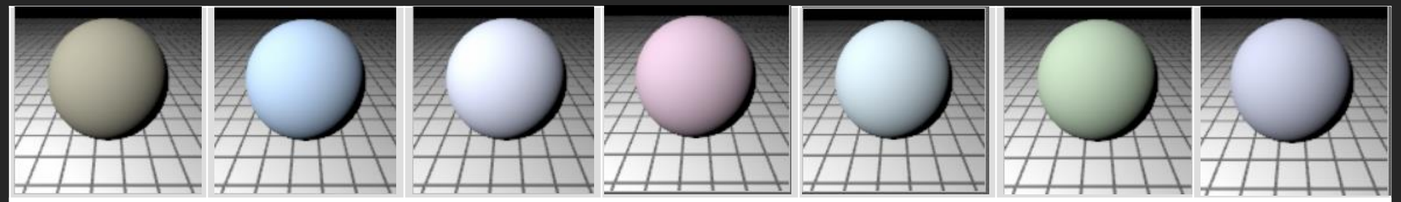
Objectives

1.Provide appropriate lighting for the space.
2.Ensure user comfort.
3.Optimize energy consumption.

.

Lighting design
(Visual/non-visual effects)

Rhinoceros ALFA DIALux

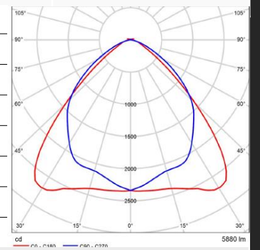


Floor	Wall	Ceiling	Furniture	Furniture	Furniture	Furniture
30%	65%	80%	50%	68%	50%	50%

Φ_{total}	P_{total}	Luminous efficacy
23520 lm	137.6 W	170.9 lm/W

pcs.	Manufacturer	Article No.	Article name	P	Φ	Luminous efficacy
4	Regiolux	SRT+19510006090	SRT+SRGCB/1500 LED 6000 830 DALI vw	34.4 W	5880 lm	170.9 lm/W

Article No.	SRT+19510006090
P	34.4 W
Φ_{Lamp}	–
$\Phi_{Luminaire}$	5880 lm
η	–
Luminous efficacy	170.9 lm/W
CCT	3000 K
CRI	80



P_{total}	A_{Room}	Lighting power density	$\bar{E}_{perpendicular\ (Working\ plane)}$
137.6 W	30.00 m²	4.59 W/m² = 0.84 W/m²/100 lx (Room) 6.88 W/m² = 1.26 W/m²/100 lx (Working plane)	544 lx

Annual energy consumption

	Uncontrolled	Controlled	Saving
Energy consumption (kWh/a)	275	61.6	214
LENI (kWh/(m² * a))	9.18	2.05	7.13
Costs (RIA/a)	82.64	18.48	64.17
CO_2 (kg/a)	110	24.7	85.8

Daylight autonomy: 65 %

Planning data

Utilisation profile	Offices (34.2 Writing, typewriting, reading, data processing)
Target illuminance	500 lx
Utilisation times	7:00 - 18:00 o'clock
Days per Week	5 (Mon - Fri)

Building 1 · Storey 1 · Room 1 (Light scene 1)

Summary

Results

	Symbol	Calculated	Target	Check	Index
Working plane	$\bar{E}_{perpendicular}$	544 lx	≥ 500 lx	✓	WP1
	U_0 (g_1)	0.61	≥ 0.60	✓	WP1
	Lighting power density	6.88 W/m²	–		
		1.26 W/m²/100 lx	–		
Glare	UGR_{max}	18.3	≤19.0	✓	CP1
Glare valuation(1)	$R_{UGL\ max}$	23	≤ 19	✗	
Energy estimation(2)	Consumption	61.6 kWh/a	–		
Room	Lighting power density	4.59 W/m²	–		
		0.84 W/m²/100 lx	–		

(1) Based on a rectangular space of 6.000 m x 5.000 m and SHR of 0.25.
(2) Calculated using hourly rating method with medium sky (without direct sunlight).

Utilisation profile: Offices (34.2 Writing, typewriting, reading, data processing)

Results and Analysis

1.Illuminance Metrics:

1. Achieved required horizontal illuminance levels.
2. Adequate lighting on the work desk, monitor, and bookshelf.
3. Satisfactory uniformity and cylindrical illuminance.
4. Appropriate modeling index values.

2.Glare Analysis:

1. Acceptable glare levels for standing and seated users.
2. Effective glare reduction strategies implemented.

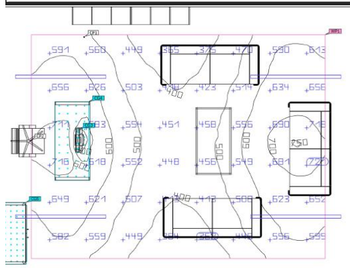
3.Energy Consumption:

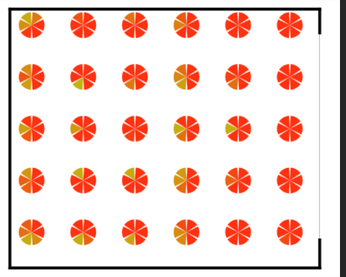
1. Reduced energy consumption with integrated daylight control.
2. Detailed energy and daylight usage patterns documented.

4.Non-Visual Comfort:

1. Assessed and ensured user comfort based on non-visual indices.

M/P	1.14
Melanopic Lux(avg)	682
Photopic Lux (avg)	598



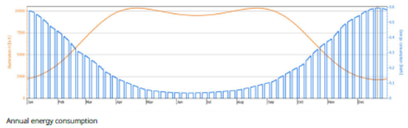


Arak Office

DIALux

Building 1 · Storey 1 · Room 1

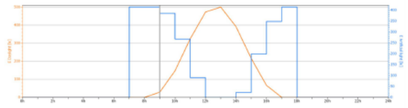
Energy evaluation day (12/21/2022 09:00)



Annual energy consumption

Daily viewing: 12/21/2022

Energy consumption		Saving	
Uncontrolled	1.06 kWh	Energy	0.47 kWh
Controlled	0.59 kWh	Costs	0.14 RIA
		CO_2	0.19 kg



Daily schedule

Point in time viewing: 09:00

Illuminance / Power consumption		Saving	
E Artificial light	386 lx	P	6.64 W
E Daylight	28.6 lx		
P	89.7 W	Shading	Open/None

Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	473 lx		
P	0.00 W	Shading	Open/None

Point in time viewing: 15:00

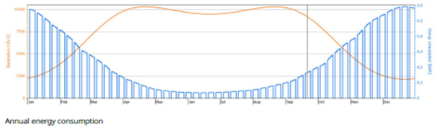
Illuminance / Power consumption		Saving	
E Artificial light	199 lx	P	50.1 W
E Daylight	216 lx		
P	46.2 W	Shading	Open/None

Arak Office

DIALux

Building 1 · Storey 1 · Room 1

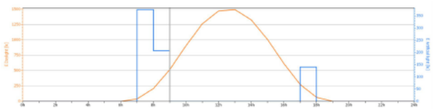
Energy evaluation day (9/21/2022 09:00)



Annual energy consumption

Daily viewing: 9/21/2022

Energy consumption		Saving	
Uncontrolled	1.06 kWh	Energy	0.89 kWh
Controlled	0.17 kWh	Costs	0.27 RIA
		CO_2	0.36 kg



Daily schedule

Point in time viewing: 09:00

Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	515 lx		
P	0.00 W	Shading	Open/None

Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	1.474 lx		
P	0.00 W	Shading	Open/None

Point in time viewing: 15:00

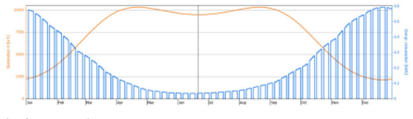
Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	1008 lx		
P	0.00 W	Shading	Open/None

Arak Office

DIALux

Building 1 · Storey 1 · Room 1

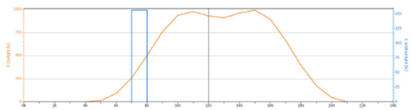
Energy evaluation day (6/21/2022 12:00)



Annual energy consumption

Daily viewing: 6/21/2022

Energy consumption		Saving	
Uncontrolled	1.06 kWh	Energy	1.02 kWh
Controlled	0.036 kWh	Costs	0.31 RIA
		CO_2	0.41 kg



Daily schedule

Point in time viewing: 12:00

Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	928 lx		
P	0.00 W	Shading	Open/None

Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	928 lx		
P	0.00 W	Shading	Open/None

Illuminance / Power consumption		Saving	
E Artificial light	0.00 lx	P	96.3 W
E Daylight	758 lx		
P	0.00 W	Shading	Open/None

Building 1 · Storey 1 · Room 1 (Light scene 1)

Calculation objects

Working planes

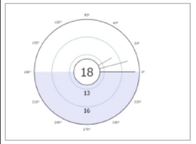
Properties	Ē (Target)	E_{min}	E_{max}	U_o (g_1) (Target)	g_2	Index
Working plane (Room 1) Perpendicular illuminance (adaptive) Height: 0.800 m, Wall zone: 0.500 m	544 lx (≥ 500 lx) ✓	330 lx	750 lx	0.61 (≥ 0.60) ✓	0.44	WP1

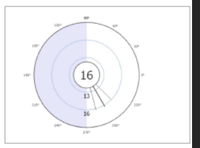
Calculation surfaces

Properties	Ē	E_{min}	E_{max}	U_o (g_1)	g_2	Index
SCREEN Horizontal illuminance Height: 1.047 m	671 lx	656 lx	682 lx	0.98	0.96	CG3
SCREEN Cylindrical illuminance Height: 1.047 m	289 lx	280 lx	293 lx	0.97	0.96	CG3
TABLE Horizontal illuminance Height: 0.765 m	649 lx	433 lx	731 lx	0.67	0.59	CG4
TABLE Cylindrical illuminance Height: 0.765 m	347 lx	245 lx	403 lx	0.71	0.61	CG4
SHELF Perpendicular illuminance Height: 1.200 m	640 lx	508 lx	737 lx	0.79	0.69	CG5

Calculation objects

STAND (UGR)		SITTING (UGR)	
Strongest glare at	0°	Strongest glare at	300°
max	18.3	max	16.2
Target	≤19.0	Target	≤19.0
Viewing sector	0° - 180°	Viewing sector	270° - 90°
Step width	15°	Step width	15°
Height	1.100 m	Height	0.445 m
Index	CP1	Index	CP2





Conclusion

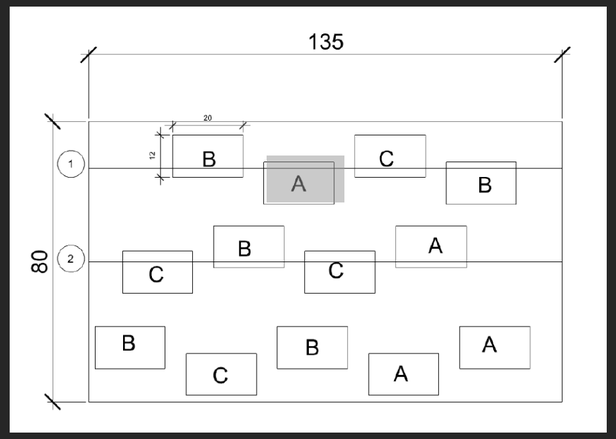
The lighting design for the selected office space in Arak effectively balances user comfort, energy efficiency, and compliance with regulatory standards. The use of DIALux for design and Alpha software for non-visual comfort assessment ensures a comprehensive approach to modern lighting design challenges. The project demonstrates the successful integration of artificial and natural lighting to create a comfortable and energy-efficient work environment.

Introduction
The objective of this exercise is to select an optimal building block from a site plan based on massing regulations for daylight reception. After selecting the best building (Block A) from options 1 and 2, an analysis of the window-to-wall ratio (WWR) for the southern facade was conducted to determine the most suitable ratio. The exercise then involves daylight and glare simulations using Honeybee or Climate Studio, followed by proposing two internal layout alternatives for an office space, evaluating the effect of shading devices on daylight intensity and glare, and assessing the performance based on LEED certification credits.

Objectives
1.Select the best building block based on daylight analysis.
2.Determine the optimal WWR for the southern facade.
3.Simulate daylight and glare for the chosen space.
4.Design two internal layout alternatives.
5.Evaluate the impact of shading devices on daylight and glare.
6.Achieve LEED certification credits for the proposed designs.

Office daylight
(plan design)

grasshopper ClimateStudio Rhinoceros



Process

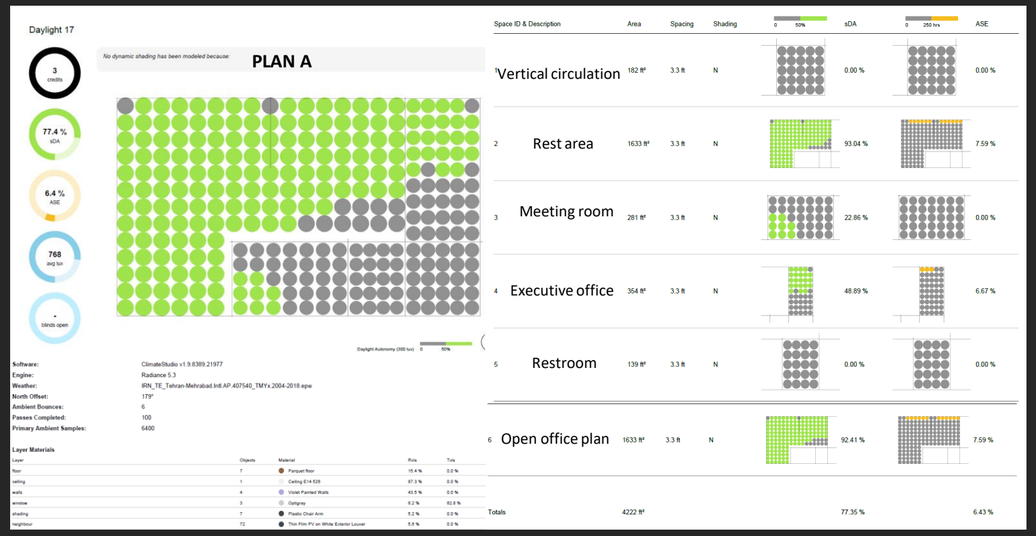
1.Building Selection: Block A was selected from the site plan as the optimal building based on daylight reception analysis.

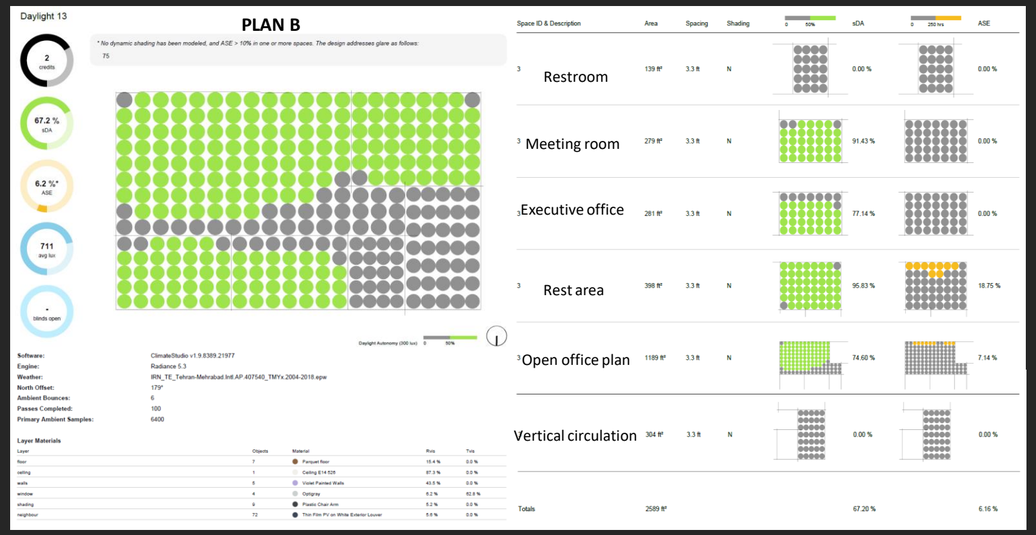
2.WWR Analysis: Three WWR options (33%, 50%, 75%) for the southern facade were analyzed based on ASE (Annual Sunlight Exposure), UDI (Useful Daylight Illuminance), SDG (Spatial Daylight Glare), and sDA (Spatial Daylight Autonomy). The 50% WWR was found to be the best option.

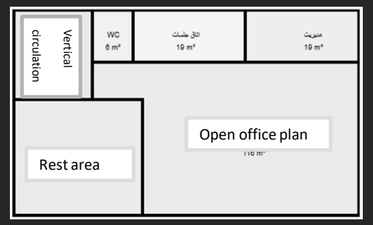
June

12 15

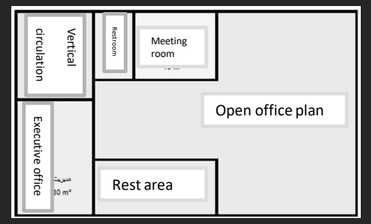
SENARIO 1 (WWR:33%)									
June				December				sDA:	65.5
15		12		15		12		ASE:	15.3
Mean:	857	Mean:	849	Mean:	3019	Mean:	4206	UDI:	50
0Median	304	Median	296	Median	541	Median	704	SDG:	26
SENARIO 2 (WWR:75%)									
June				December				sDA:	91
15		12		15		12		ASE:	27
Mean:	1369	Mean:	1376	Mean:	4936	Mean:	666	UDI:	66
Median	615	Median	606	Median	1033	Median	1439	SDG:	41.3
SENARIO 3 (WWR:50%)									
June				December				sDA:	92
15		12		15		12		ASE:	20.2
Mean:	1148	Mean:	1149	Mean:	4273	Mean:	418	UDI:	66.5
Median	482	Median	462	Median	805	Median	178	SDG:	35.1







		UDI	ASE	SDA	SDG
1	Vertical circulation	0	0	0	0
2	Open office plan	77	7.5	91	15
3	Meeting room	20	0	22	16
4	Executive office	42	6.6	51	19
5	Restroom	0	0	0	19
6	Rest area	76	7.5	90	6



		UDI	ASE	SDA	SDG
1	Vertical circulation	0	0	0	0
2	Open office plan	65.88	7.14	74.60	11
3	Meeting room	76.14	0	91.43	0
4	Executive office	67.78	0	77.14	0
5	Restroom	0	0	0	0
6	Rest area	78.87	18.75	95.83	16

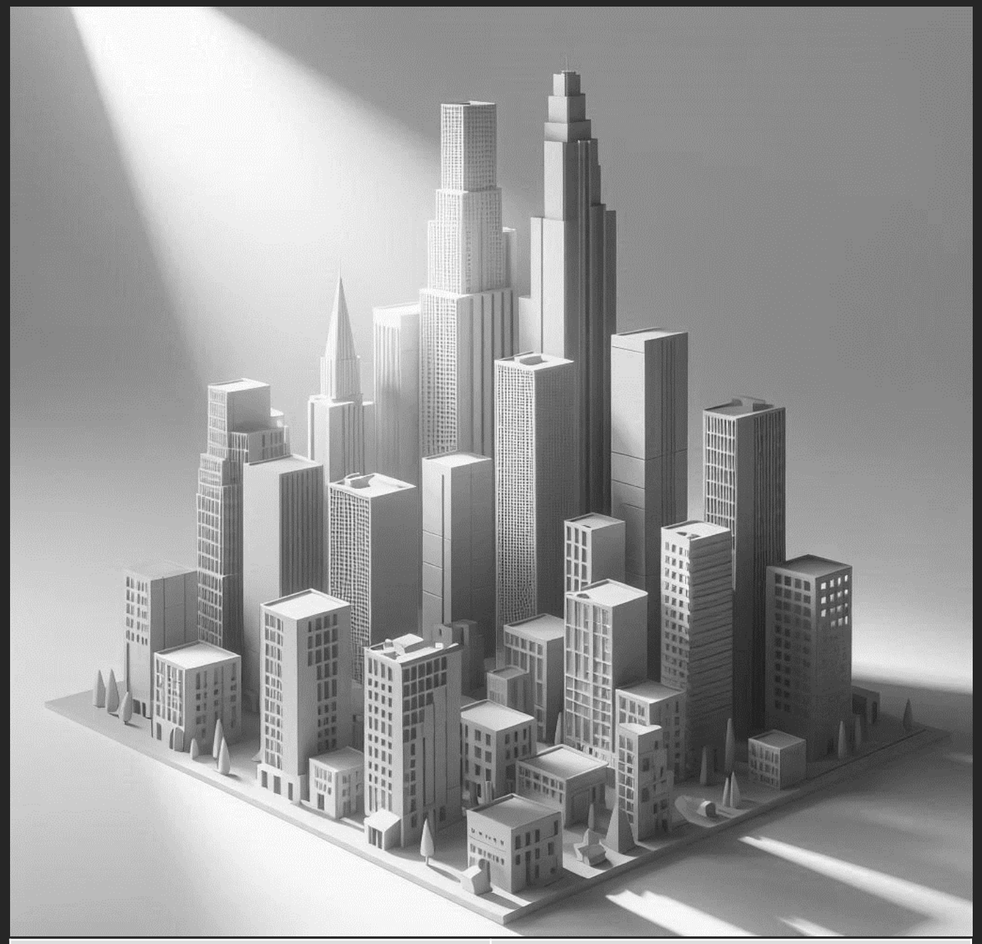
1.Simulation: Daylight and glare simulations were conducted for both layouts using Honeybee/Climate Studio for annual conditions at 9 AM and 3 PM on the solstices. Metrics such as UDI, ASE, sDA, and SDG were evaluated for each space to ensure adequate daylight.

2.Evaluation: Both layouts were suitable based on the daylight metrics. The first layout achieved 3 credits, and the second layout achieved 2 credits in the LEED certification.

Conclusion and Analysis

The 50% WWR was determined to be the optimal ratio for daylight performance. Both internal layouts provided sufficient daylight with minimal glare, achieving LEED certification credits. The proposed shading devices effectively controlled daylight intensity and reduced glare throughout the year. The first layout was more favorable, achieving higher LEED credits, but both layouts met the necessary daylighting standards.

This exercise demonstrated the importance of thorough daylight analysis and thoughtful design in achieving energy-efficient and comfortable office spaces. The use of advanced simulation tools ensured accurate predictions of daylight performance, guiding design decisions that enhance occupant comfort and energy efficiency.



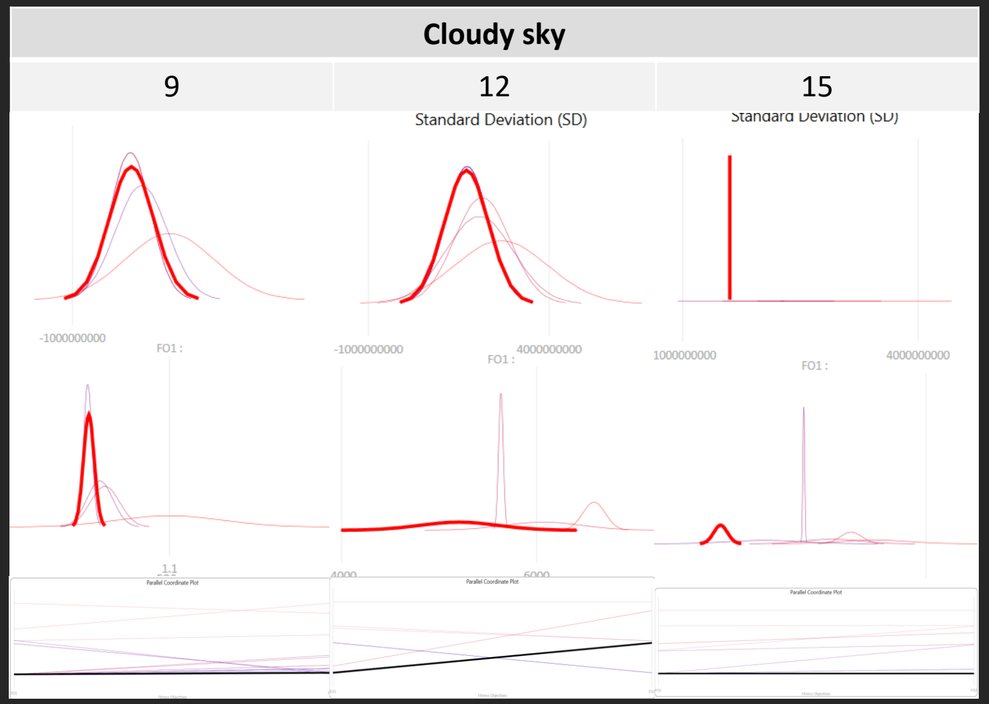
angle	1
WWR	0.48
U-factor	2.5
Shgc	0.8

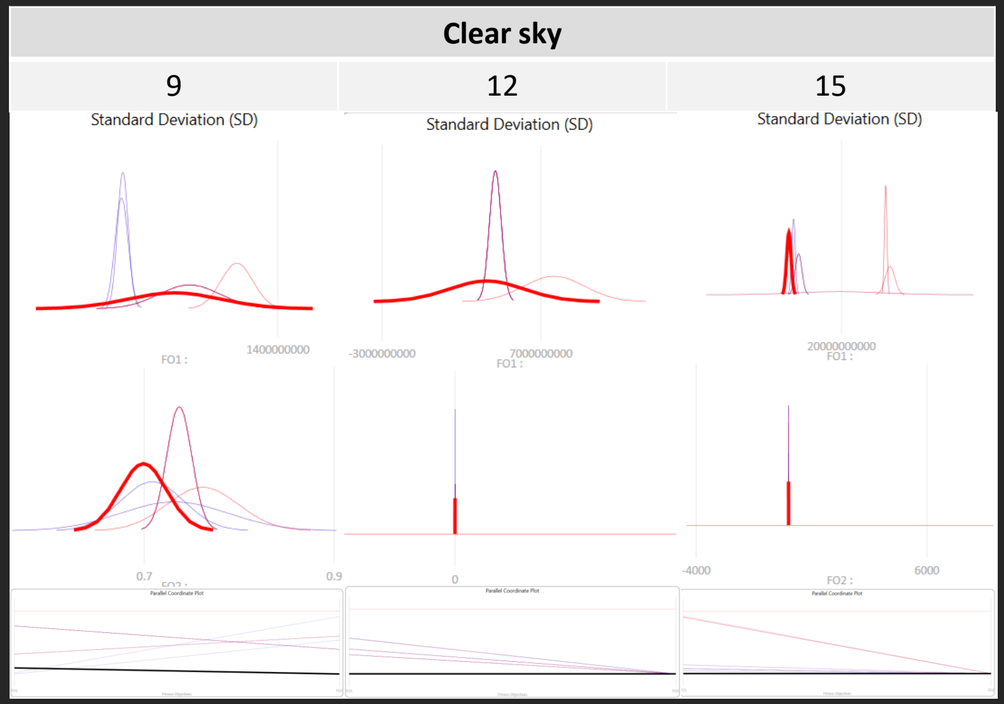
Introduction
In this exercise, we aim to optimize lighting and glare conditions in an office space with a movable facade and light-transmitting materials on the south-facing wall. The first step involves designing a movable facade with 10 stages of adjustment for the given space. The initial objective is to optimize the window-to-wall ratio (WWR) and building orientation to reduce the building's thermal load. This requires a single-objective optimization using the Galapagos tool in Grasshopper.

Objectives
1.Provide adequate lighting on the users' work desks.
2.Control glare.
3.Reduce energy consumption for artificial lighting.
4.Increase lighting uniformity within the interior space.

Optimization Variables
1.Window-to-Wall Ratio (WWR): Ranges from 30% to 80% (continuous).
2.Building Orientation: Angle relative to the north-south axis, ranging from -45 to +45 degrees (continuous).
3.Glass U-Factor: Thermal transmittance coefficient of the glass, ranging from 2.5 to 5.5 W/m².K (continuous).
4.Solar Heat Gain Coefficient (SHGC): Ranges from 20% to 80% (continuous).

Optimizing Office Lighting





Process

Step 1: Thermal Load Optimization

Using the Galapagos plugin in Grasshopper, we optimized the variables (WWR, building orientation, U-Factor, and SHGC) to minimize the thermal load on the building. The optimization was performed for the city of Arak, considering its specific climatic conditions.

Step 2: Daylighting and Glare Control

Based on the optimal results from the first step, we proceeded to optimize the facade design for different times of the day (9:00, 12:00, and 15:00) under varying sky conditions (maximum and minimum cloudiness). This was done using the Wallacei plugin in Grasshopper to achieve the following goals:

•Ensure sufficient lighting levels on work desks.
•Control glare within acceptable limits.
•Minimize the use of artificial lighting.
•Enhance uniformity of natural light in the interior space.

Tools Used

1.Grasshopper: For parametric modeling and integrating various plugins.
2.Galapagos: For single-objective optimization of thermal load.
3.Wallacei: For multi-objective optimization focusing on daylighting and glare control.

Results

The optimization process provided the following optimal values for the specified variables:

•**WWR:** Achieved optimal balance between natural light and thermal load.
•**Building Orientation:** Positioned to maximize daylight while minimizing direct sunlight exposure during peak hours.
•**Glass U-Factor:** Selected to ensure appropriate thermal performance.
•**SHGC:** Optimized to balance solar heat gain and daylight penetration.

Analysis and Conclusion

The optimization demonstrated significant improvements in lighting conditions and energy efficiency:

•**Adequate Lighting:** Ensured that the work desks received sufficient natural light during working hours.
•**Glare Control:** Maintained glare within acceptable limits, enhancing visual comfort for users.
•**Energy Savings:** Reduced reliance on artificial lighting, leading to energy savings.
•**Lighting Uniformity:** Achieved a more uniform distribution of light within the space, improving overall visual comfort.

Thank You

I would like to express my heartfelt gratitude to Dr. Mohammad Tahsildoost and Mr. Amirfarbod Shahverdi for their invaluable guidance and support throughout this course. Your teachings on sustainable design have profoundly influenced my understanding of creating better environments for both humanity and the planet. You have not only equipped me with the technical skills necessary for designing sustainable solutions but also instilled in me a deep sense of responsibility and care for the environment and human well-being. Thank you for teaching me to be a thoughtful problem solver and for inspiring me to make a positive impact through my work.

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