Evaluation of daylight performance of the new workshop building at CEPT University, Ahmedabad

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Abstract

This study uses calibrated simulations to evaluate the daylight performance of the new workshop building at CEPT University, Ahmedabad, India, and to validate Lighstanza as a daylighting simulation tool. The methodology included field measurement and calibrating a daylight model. The calibrated model of the building has an RMSE (Root mean square error) and an NMBE (Normalised mean biased error) of less than 4%. The building was found to be LEED v4 and Energy Conservation Building Code 2017 (ECBC) compliant. The current manual switching response to daylight saves € 1,066 per year. The Daylight Glare Probability analysis showed that the spaces experience glare issues only between 5-6 PM during the summer months.

Introduction

India is experiencing increasing urbanization and the majority of building energy in urban areas is consumed by cooling, ventilation through fans and artificial lighting (S Yu, M Evans, 2014). Daylighting can be a useful strategy to conserve energy and can give energy savings up to 45% (Debnath and Bardhan, 2015). There are various studies done on daylighting and visual comfort in spaces such as retail, classrooms and offices. Students in classrooms with daylight had 7-18% higher test scores than those students who had least daylight in their classrooms (Heschong mahone group, 1999). Chen et al., (2014) state that there are only a limited number of studies on daylighting for industrial buildings where lighting is a major electricity consumer. In case of low surface reflectance, or a task where higher visual capacity is required, accidents can be caused by failure to see or failure to understand what is seen. Most accidents that are caused by poor illumination are avoidable with proper planning in the use of daylight illumination (Oweikeye, Amasuomo and Alio, 2013). The findings from such studies make a case for understanding the actual daylight performance of the workshop at CEPT University.

The new workshop building at CEPT University, Ahmedabad was designed by architect Gurudev Singh. The new building accommodates studios for Model Making, Wood working, Metal working, Ceramics & Clay, Weaving/Textile, Print & Print Making and Fab Lab CEPT. Ahmedabad has a clear sky climate throughout the year except for monsoon months. The design of the workshop is intended to provide daylight during occupancy hours (Singh, 2018). The workshop has a rectangular plan form with an area of 1,685 sq. m. It is a facility with high ceiling, north facing windows and large clear spans (Figure 1) to accommodate the need of each activity. The architect and the university facilities managers were interested in knowing if shading devices were required, or if there was any glare that may cause safety issues while operating the workshop equipment. The study determined whether the workshop requires additional shading in any form. According to the Energy Conservation Building Code (ECBC) of India, the lighting power density for a workshop facility is high at 14 W/m^2 and these spaces can have very high lighting energy use. The quantification of the daylighting savings can impact the future decisions on this building type which has one of the highest lighting energy use.

The approach of this study was to measure illuminance and surface characteristics, record lighting usage patterns, calibrate a daylight model, and perform annual simulations to evaluate the daylight performance for visual comfort and energy savings potential. While this building has exemplary daylight performance, the parametric study estimates the value of design decisions (such as material choices) in terms of the impact on lighting energy savings.

This study validates Lightstanza as a tool for daylighting simulations. Sketchup 3-D Models were imported in to Lighstanza, which provides an easy-to-use browser-based interface, but limited access to settings of the Radiance engine. This validation exercise is a significant research contribution of the study. The methodology adopted to evaluate the daylight performance can be used for any building type.

Figure 1: A visual depicting white finishes of ceiling, display cupboard and open doors in the workshop

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Methodology

The methodology for this study is broadly divided into four sections i.e. data collection and field measurements, model calibration, performance analysis using calibrated model, and parametric analysis.

Data collection and field measurements

Data collection was carried out in order to understand the design intent of the workshop. This included reviewing building drawings, visit to the site and interviewing the architect of the building. Literature review was done, and photographs were taken to document the building elements and daylit spaces in the workshop.

Field measurements were carried out for instantaneous and long-term monitoring.

1. Field measurements

- Point-in-time illuminance (PIT) values were measured using KM-99 Digital lux meter (Figure 4). The field measurements were done in the model-making part of the workshop, which is a representative space, on a grid of 0.6 x 0.6 m at a work plane height of 0.75 m. Outdoor illuminance was measured every 5 mins for the same time period to ensure that oudoor levels did not vary considerably during the measurement period. Illuminance and exitance values were measured for interior surface finishes to calculate surface reflectance values (Figure 6).

- Instrument details-Manufacturer: Kusam Meco, Accuracy: ± 5%, Range:0-50,000 lux

2. Long term monitoring

Figure 4: KM-99 digital lux meter used to measure PIT value and surface reflectance.

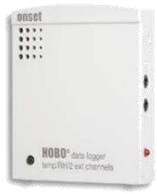

Figure 4: HOBO data loggers used for long-term monitoring

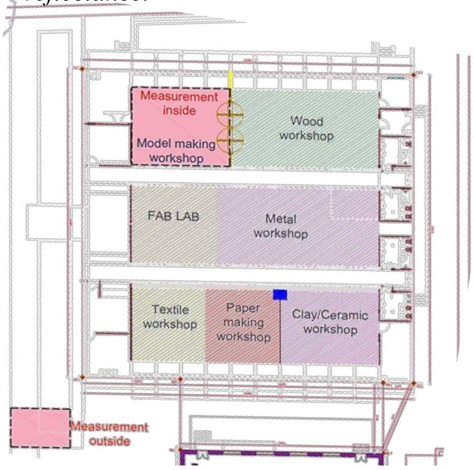

Figure 4: Location of field (indoor and outdoor) measurement in workshop.

- Onset U12 HOBO (Figure 4) data loggers were used to measure the illuminance levels at 10 minute intervals for a period of one week and derive the light switching patterns by analysing the data.
- Instrument details-Manufacturer: Onset, Range for light intensity:1-3000 lux, Accuracy: ± 2.5%.
- Placing the logger on top of the shelf (Figure 5) allows a stronger signal to be read when the electric lights are turned on during daylit hours.

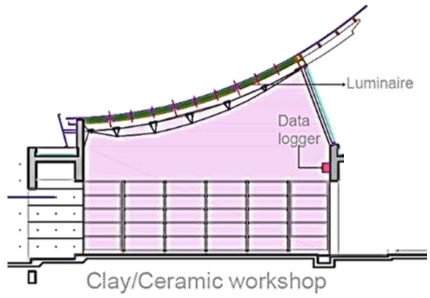

Figure 5: Location of data loggers placed above the wooden shelves in the ceramic workshop in section.

3D modelling and model calibration

The 3D model was set up with geometry and material definition (Figure 4) using Sketchup software to import it into cloud-based software Lightstanza (LightStanza, 2017) for daylight simulation. Daylight simulation was performed in Lightstanza for the same time of the year as the measurements, with TMY data for Ahmedabad on 4th March at 12:00 noon. The simulation was done with a grid spacing and workplane height same as that for field measurements. The difference was calculated between measured and simulated values. The results are compared using daylight section curves.

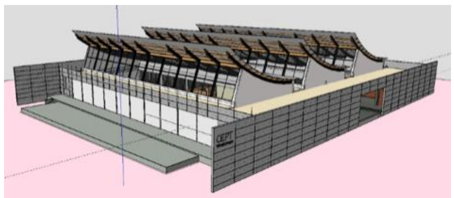

Figure 6: 3d model used for daylight simulation

The objective of calibration was to minimize the difference between the on-site measurement data and simulated results by making reasonable changes to the model inputs (Table 1). Inputs such as dust factor on the glazing, accurate furniture and door positions, surface reflectance values, etc. are adjusted.

The calibration process involved identifying and listing down the factors affecting direct component, externally reflected components (ERC) and internally reflected components (IRC) of daylight and checking the model for light leaks through hemispherical renderings. Inputs that affect the direct component of daylight are investigated to correct large differences, and those that affect the internal and external reflected components are investigated for small differences (Table 1). RMSE and NMBE are calculated, and the process of calibration was used to reduce these to match the overall daylight section curves.

Table 1: Identifying factors affecting daylight in a space-SC+ERC+IRC

Possible differences	Direct sky component	Internal reflected component (IRC)	External reflected component (ERC)
People			
Furniture location			
Door swing			
Glazing dust factor			
Machinery			
Exterior china mosaic			
Ext. trees and buildings			
Trusses			

Factors affecting the direct component of daylight are adjusted to calibrate the model and reduce the error in the acceptable range as follows-

- The model was built by using the drawings provided by the architect. The furniture location and size needed to match that in the building (Figure 8)
- The door swing of partition wall was open in the 3d model, but they were closed during the measurements and this needed to be matched (Figure 9).
- Changing the visible transmittance (VT) of the glazing of north openings by considering a dust factor i.e. effective VT (Figure 10)

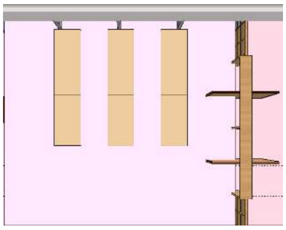

Figure 8: Model before making any corrections in plan (as built)

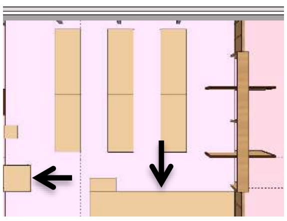

Figure 7: Step 1, matching the furniture layout as per the existing

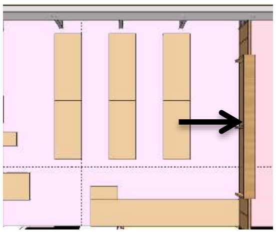

Figure 10: Step 2, closing the doors in plan (with dust factor) in section.

Figure 9: Step 3, changing the VT of the glass with an effective VT

Performance Analysis

To evaluate the daylight performance of the workshop, the 3d model of the building was simulated for its annual performance, the lighting energy savings were estimated based on long-term monitoring and visual comfort was assessed by carrying out glare analysis.

1. Annual performance
   Daylight simulation was performed for the whole workshop building to evaluate the annual performance (Table 2) in Lightstanza.

Table 2:Annual metric used in this study and their thresholds

Annual metric	Performance threshold	Purpose of the daylight metric in the study	Source
sDA	75%(area) $sDA_{300/50\%}$ (300 lux for 50% of the time)	LEED threshold for daylight compliance	LM-83, IESNA
ASE	10%(area) $ASE_{250/1000}$ (250 hours,1000 lux)	LEED threshold for daylight compliance	
UDI	40 % of total building area with 90% $UDI_{100,2000}$ (100-2000 lux)	ECBC 2017 daylight compliance	ECBC 2017
DA	$DA_{400/50\%}$ NBC: $DA_{750/50\%}$ (Refer Appendix D.8 for process)	To estimate the lighting energy savings potential with switching controls as per NBC set-point. (On/Off)	Long-term monitoring-data logging
cDA	cDA $_{400/50\%}$ NBC: $cDA_{750/50\%}$ (Refer Appendix D.8 for process)	To estimate the lighting energy savings potential with dimming controls for per NBC set-point.	Long-term monitoring-data logging

2. Lighting energy savings

- Since there was no other data of existing operation for the representative space as a base case for lighting energy savings, the workshop with lights turned on for all occupied hours (no daylighting) was considered as the baseline case.
- The long-term monitoring data for Jan 12-18 was analyzed and to identify the times of the day when lights transition from off to on and vice versa. Jan 12-18 was simulated with the calibrated model for these transition times. Using the simulation results, the threshold illuminance at the critical task point in the space is identified for that transition time.
- The simulated illuminance level at the critical point was then used as a threshold number for annual simulation-DA (switching control) and cDA (dimming controls). The DA or cDA value is assumed

to be the percentage of lighting energy that will be turned off or dimmed respectively.

- The lighting energy savings for each case will be calculated as follows-
  Total lighting watts installed x (hrs. of use) x (% lighting energy off or dimmed) x (Area)= kWh/year

3. Glare Analysis

- Simulation in Lightstanza was performed for Annual sun exposure (ASE) and hemispherical view rendering. The results for renderings are generated for the option “4 seasons” in Lightstanza. The results are simulated at equinox and solstice days of the year. The occupied daylight hours considered for the simulations are the occupied hours of 10 am to 6 pm. Radiance settings were adjusted in Lightstasnza to get accuracy in results and smooth renderings.
- Glare analysis was done for 6 points in different spaces of the workshop. For each of the point, human eye level scenes (5’5”) were simulated in each cardinal direction with the garage doors open and closed (Excluding the views when the camera face the wall point-blank). In total, there were 44 view renderings done for glare analysis.

Parametric Analysis

The workshop appears to have followed several best practice design decisions. The intent of the parametric analysis was to document the improvement in performance as a result of these decisions compared to the typical or traditional design decisions that are taken on the CEPT campus for other building in terms of the impact on lighting energy savings.

Simulations in Lightstanza are performed by making changes to the calibrated model based on different parameters listed in Table 3 to calculate the impact of major design decisions in the workshop using daylighting autonomy metrics. Each parameter is changed one at a time in the calibrated model and its impact is assessed through ASE (glare), DA and sDA. The combination is assessed in the case of surface reflectance only.

Table 3: Parameters for which the calibrated model will be simulated

EXISTING DESIGN	**Orientation**			
	North-facing	East	West	South
	Visible Transmittance of DGU glass (%)			
	64.4%- Including dust factor	74-When the glass is clean	60%- When the glass is partially clean	44%- Glass heavily coated on dust
	Surface reflectance (%) ceiling			
	73% (White laminate)	38% Exposed concrete		
	Surface reflectance (%) floor			
	53% (epoxy flooring)	21.7% (Kota stone)		
	Surface reflectance (%) wall			
	80% (White paint)	43% (Brick work)		
	Surface reflectance (%) combination			
	Ceiling	Floor	Wall	
	38% (Exposed concrete)	21.7% (Kota stone)	43% (Brick work)	
	Window to floor area (WFA) %			
	27%	20%	32%	
	Exterior roof reflectance (%)			
	90% (China mosaic)	38% (Exposed concrete)		

The parametric are selected as per the design approaches typically used in other campus buildings. Parametric for orientation are the cardinal directions at which most of the buildings at CEPT University are oriented, also the most used building materials are exposed concrete, kota stone and exposed brickwork, hence the model was simulated with these specific materials. The impact of VT of the glass was analysed when it was dust free (clean), partially clean and with dust on it. WFA of most of the studios in the campus range between 16-36% (Chaudhary, 2017), therefore parametric for WFA are considered in this range. Impact of exterior roof reflectance is also studied (Table 3).

Implementation and software related issues

During this research, there were some field measurement related and simulation related issues that were identified.

Measuring Visible transmittance of the north window openings

To calculate the effective VT, the dust factor was calculated by measuring the transmittance losses for another classroom instead of north openings at the workshop, as it was physically not accessible. The next best alternative with accessible incline windows was searched in the campus and measured, and then, the dust factor was calculated. There was a difference in the angle of inclination between the FT openings and workshop openings. The north openings at the workshop was 69°and that of the FT classroom was 57°. Therefore, there are chances of the dust-factor being under-estimated since there was more dust accumulation at the workshop openings due to the adjacent road and due to difference in angle of inclination for both the openings.

Outside illuminance

Before starting with calibration process, first it was assured that the results of outside illuminance are close for measured and simulated values. The error was high when compared for CIE clear sky, but the error was less when compared for Climate (TMY weather file of Ahmedabad) i.e. 0.09%. Therefore, Climate option was used (Table 4).

Table 4:Results of measured and simulated values for outside grid

Step	Result-Average (Lux)	Maximum (Lux)	Minimum (Lux)
	NMBE	NMBE	NMBE
Error with CIE standard sky	21.2%	21.9%	18.3%
Error with based Climate sky	0.09%	0.7%	3.7%

Glare analysis renderings

For glare analysis, there were some settings and parameters that were changed in order to get accuracy in results and smooth renderings in Lightstanza (**Error! Reference source not found.**). There were 44 renderings done and each rendering took 7-8 hours each.

Table 5: Settings that were made in Lightstanza for smooth and accurate renderings to assess glare

Setting	Function	Rendering time and image quality	Maximum value for accuracy	Value used for renderings
-ab Ambient bounces	Maximum no. of diffuse bounces inside the space computed	Doubles the rendering time for the no. Higher the no. of bounces, more accurate is the quality	8	8
-ad Ambient divisions	Decreases the splotches of light due to indirect incident light	Doubles the rendering time and increases the quality of the rendering	4096	2000
-as Ambient super-samples	No. of extra rays to spaces with high variance	Direct, adds to (-ad)	1024	800
-lr Limit reflection	Reduces the multiple reflections due to specular surfaces	Slightly longer rendering time	16	12

Results and Analysis

This section includes results from field measurements, calibration process, performance analysis and parametric analysis with more focus on the calibration process, glare analysis and lighting energy savings estimated.

Field measurements

The average illuminance in the space was 779 lux. Minimum and maximum illuminance recorded on 4th March, noon time were 1168 and 215 lux respectively.

Minimum illuminance was observed below the north windows because it has least exposure to the direct sky component and maximum illuminance was observed in the central region of the model-making space as it has maximum exposure to direct sky component (Figure 11).

The architect has used white colour in most of the interior surfaces such as walls, curved ceiling, flooring and display cupboards to increase the reflectance and to make the space look brighter.

Maximum surface reflectance measured was of the white painted walls-80%, followed by white laminated display cupboard, partition door and ceiling, all had surface reflectance of 73%. The minimum surface reflectance was of unpolished wooden table in the task area-30%. The epoxy flooring had a reflectance of 53%.

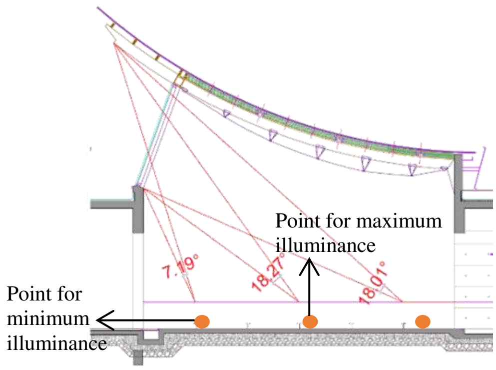

Figure 11: Points with minimum and maximum exposure to direct sky component

Model Calibration

The NMBE and RMSE results before calibration were (-31.1) % and (31.2) % respectively. In Figure 12, the grid

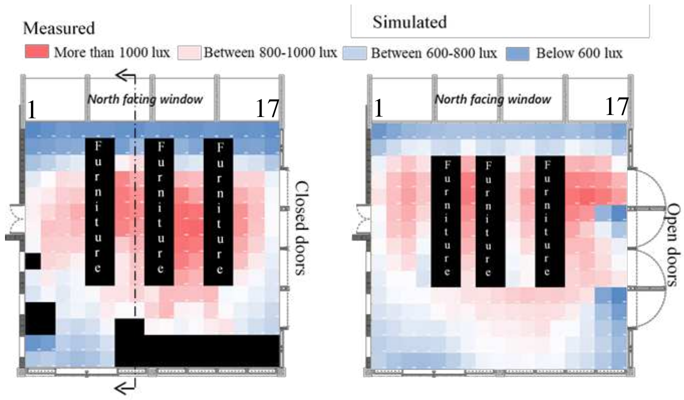

Figure 12:Plan-grid for measured and simulated results for PIT results before calibration.

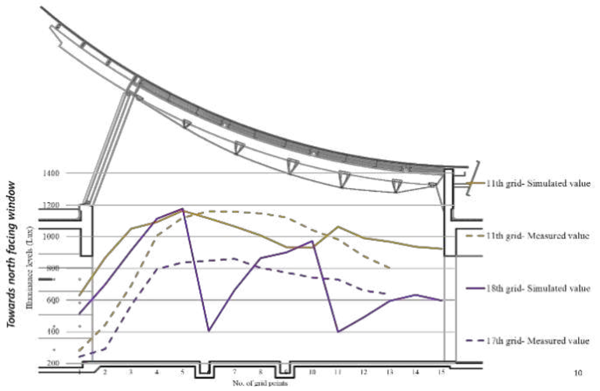

Figure 13:Difference in Grid line-11 and 17 for measured and simulated PIT results before calibration

lines below north openings of the simulated grid were receiving less illuminance as compared to measured grid.

The 3D model was considered as per the CAD drawings.

In Figure 14, measured and simulated values are compared for specific grids to observe the difference.

Maximum variation was observed in the 17th grid (Figure 12), the simulated results appear in a zig-zag pattern whereas the in the measured grid, results are consistent. For the two grid lines, the results vary for the grid lines below the north openings. There was a difference of approx. 250 lux for grid 17 and a difference of approx. 360 lux for grid 11. The results vary due to a few factors affecting the direct sky component- externally reflected component and internally reflected component of daylight that are not taken into consideration during simulation.

As compared to the simulated grid before calibration in Figure 12, the simulated grid was seen to have more illuminance at the gridlines below north openings, less at the end near the furniture and machinery and the central portion of both the grids are closer in values than before, which correlates well with the measured grid (Figure 15). Matching the furniture layout based on as-built conditions (**Error! Not a valid bookmark self-reference.**) could noticeably bring the simulated results closer to the measured ones since it impacts the direct sky component of daylight. Accounting for effective VT had the most impact out of all the steps.

Grid 11 (Figure 13) lies between two tables for task. The difference was maximum between measured value and simulated value before calibration in the grid below the north openings i.e. 380 lux, and the difference was comparatively less at the end i.e. 180 lux. The difference in the central grid was approx. 200 lux. After changing the furniture layout from as built to the existing one, the grids below the north opening came closer i.e. approx. 50-80 lux. The grids at the centre and at the end also came closer to the measured one. There was no change after closing the partition door. Since the VT was over-estimated before, changing it by using a correction factor for dust had the maximum impact i.e. it affects the direct sky component of daylight the most as compared to the other two steps. The difference was negligible below the north opening and at the end but noticeable in the central grids after calibration.

Table 6:NMBE and RMSE criteria considered and results achieved(Ruiz and Bandera, 2017)

Calibration steps	**Acceptable range of error**	**Results %**	
		NMBE	**RMSE**
Before calibration	NMBE: ±5 and 10% RMSE: 15-30%	(-31.1) %	31.2%
Matching furniture to as-built conditions		(-11.3) %	11.4%
Closing the partition doors		(-12.4) %	12.5%
Accounting for VT reduction due to dust. [Correction factor (CF)=0.13 Dust factor=(1-CF) =0.87, effective VT=64.4%]		(-3.76) %	3.78%

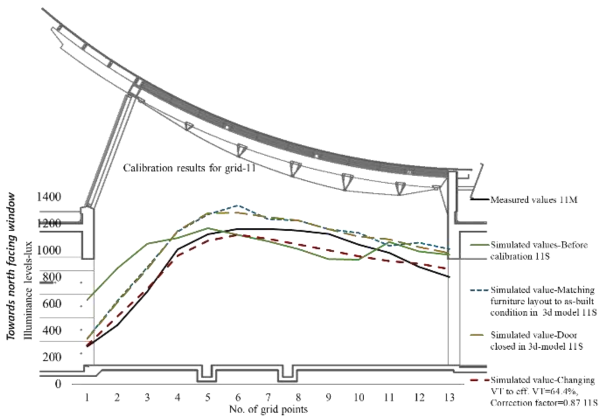

Figure 14:Comparison of measured and simulated illuminance after calibration-Grid line 11

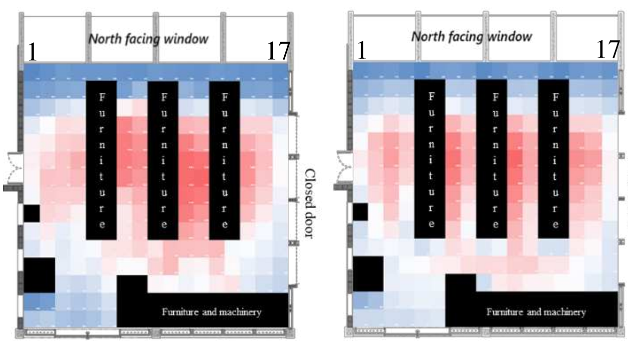

Figure 15:Comparison of measured and simulated grid after steps of calibration. NMBE: (-3.7%), RMSE: 3.8%

Performance Analysis

1. Annual Performance

- sDA and ASE simulation was done as per LEED compliance requirements for regularly occupied spaces. Corridors, storage areas, service areas and spaces with area < 250 sq. ft. are not considered.

- The UDI simulation was done as per ECBC 2017 daylight requirements. UDI was calculated as per the points on the grid that received illuminance levels in the range of 100-2000 lux for 90% daylit hours of the year.
- The workshop building meets the performance thresholds for $sDA_{300/50}$, $ASE_{1000/250hr.}$ and $UDI_{100,2000lux}$ to be 0.4%, 93% and 41% respectively.

2. Lighting energy savings estimation

As per the observations, for a baseline that has lights on, will be turned on from 10 AM till 8 pm (on average) when the workshop closes.

From the PIT simulation done on critical point performed for the monitoring time at 5:30 PM and 6 PM, it was determined that the employees in the workshop are likely to be currently operating the lights at a control set-point of about 400 lux. They are using switching controls as of now, and if they continue to consistently operate the system using switching controls, they will achieve savings equivalent to a DA_{400} of 73%. The savings in lighting energy from daylighting will be 9,603 kWh/year which will amount to €1,056 annually, when compared to a building that has its lights on for all occupied hour.

If the campus facilities team were to install automated daylighting controls, they are likely to choose the control set-point as per NBC illuminance level standards, i.e. 750 lux. The savings with switching controls was 64% and with dimming controls, it was 75%. Savings in lighting energy for switching and dimming controls was 8,419 kWh and 9,866 kWh respectively. Cost savings from switching and dimming controls were € 926 and € 1,085 respectively (Figure 16), when compared to workshop that has its lights on for all occupied hours.

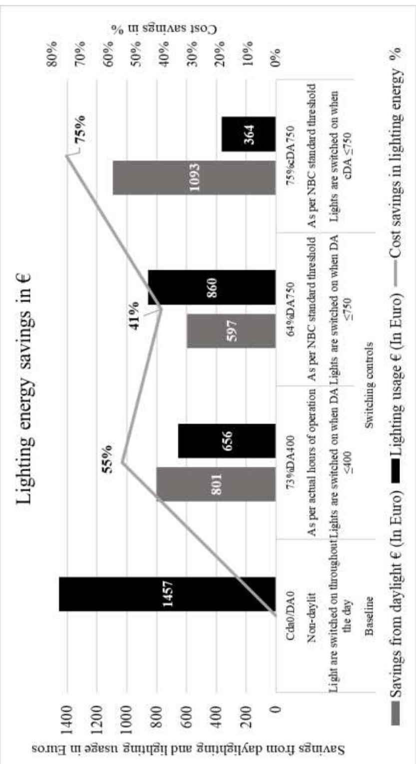

Figure 16: Cost savings from daylighting in lighting usage (€)

3. Glare Analysis

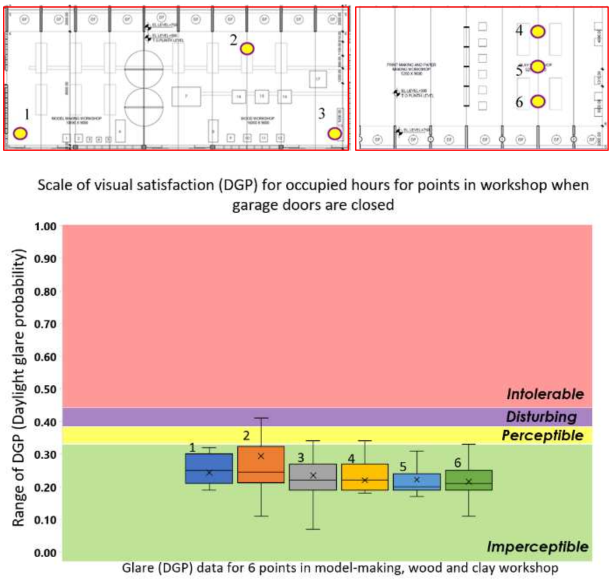

Figure 17: Analysis of glare for 6 points in the workshop from north openings for various occupied hours and plan above

Graph in Figure 17 shows a spread of the DGP values in % for all six points when the garage doors are closed, i.e. the daylight source here are the north openings only. The highest DGP value was for Point 2, which is located just next to the garage doors since it has has maximum view angle towards the north openings when compared to the other two points in the space, it is likely to experience more amount of glare. The glare can be disturbing for a few hours during occupied hours (summer months) of the day mostly between 5-6 PM.

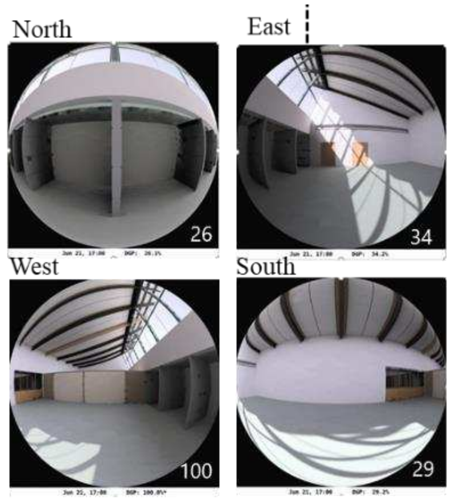

Figure 18: Renderings for Point-2 when garage doors are open and closed. DGP values in the right bottom corner of each image.

When the garage doors are closed, 89% of the occupied hours are visually comfortable i.e. the glare was imperceptible (Figure 18).

4. Parametric Analysis focussing the impact on lighting energy savings

- Orientation- North was the optimum orientation for the workshop building, since for site orientation other than north, the ASE value was much higher than the performance threshold value. Though, the $DA_{75050\%}$ and $sDA_{300/50\%}$ values are higher, the spaces will experience visual discomfort in east, west or south orientation.
- VT- Maximum daylight was achieved when the glass opening was fully clean as it was impacting the amount of exposure to the sky component, also the adjacent road and earth moving happenings at the workshop contributes to the amount of dust (Table 7).
- Surface reflectance- The existing combination of materials used in the workshop contribute better as compared to other parametric options (materials commonly used at the campus). White surfaces used at the ceiling, wall and flooring provide the highest reflectivity in the bays. Therefore, the existing materials contribute in providing optimum daylight.
- Exterior roof reflectance- As per results in Table 7 use of china mosaic chips are impacting the externally reflected component (ERC) but its contribution to the overall daylighting was small.
- WFA- WFA ratio plays an important role in the performance of daylight, as per the results in the daylight performance of the workshop will improve if the WFA was increased. Therefore, the size of the openings can be optimized.

Conclusion

This study has validated Lightstanza as a tool for daylighting simulations. The RMSE and the NMBE were less both than 4%. The user interface of Lightstanza with limited access to Radiance settings was adequate to simulate complex 3-D geometry with curved roofs, customize building materials, and run point-in-time as well as annual simulations to report results required by energy codes and green building rating systems. Lightstanza also enabled glare evaluation of the space.

Field measurements results are compared with simulated results for the same day, time and TMY weather file of Ahmedabad was used for same sky condition. The daylight model was calibrated using a series of steps to reduce the error. The calibrated model was then used to evaluate annual performance, assess visual comfort, calculate potential lighting energy savings and do parametric analysis.

In terms of daylight performance, the workshop building is performing exceptionally well. The workshop building is LEED and ECBC daylight compliant.

In terms of glare related visual comfort, overall the workshop faces no shading or harsh sun issues. Diffuse light enters the space for most of the year. The spaces inside the workshop are likely to experience glare issues during the summer months, mostly between the time period 5-6 PM when direct sun penetrates the space. The spaces are visually comfortable, since the glare is in the imperceptible range for most of the time in the months of December, March and September.

If the facilities team of the workshop continue to consistently operate their system using switching controls as per existing switching pattern and usage, they will achieve savings in lighting energy of 9,603 kWh/year and cost savings will be € 1,064 annually, when compared to a building that has lights on for all occupied hours. If the facilities team were to operate the lighting system with automated controls, they are likely to choose the control set-point value as per NBC illuminance level standards i.e. 750 lux. Savings in lighting energy for switching and dimming controls was 8,419 kWh and 9,866 kWh respectively. Cost savings from switching and dimming controls was € 932 and € 1,093 respectively, when compared to a building that has lights on for all occupied hours.

The intent of the parametric analysis was to document the lighting energy savings and performance as compared to BAU in CEPT campus in case of switching controls. If the typical CEPT surface materials palette was used (Table 7), the difference in the lighting energy savings as compared to the existing design strategies used in the workshop will be € 204 i.e. the loss in savings annually. The percentage difference is 36%. Therefore, the upcoming buildings in the CEPT campus are likely to achieve significant amount of lighting energy savings if a building is constructed with representative design strategies as that of the workshop.

Table 7: Overview of the difference in savings for switching controls

Parameters	Daylight autonomy	Lighting usage	Lighting energy savings from daylight	Difference in savings compared to existing workshop parameters
Switching controls	DA 750/50%	kWh	Rs.	Rs.
Existing workshop	46	7103	**54460**	
Visible transmittance				
Clean glass, VT=74%	55	5919	65115	-10655
When the glass is partially covered with dust	41	7761	48540	5920
When the glass is covered with dust, VT=44%	20	10524	23678	30782
Surface reflectance (Typically used in CEPT)				
Ceiling, Exposed concrete	38	8156	44988	9472
Wall, Reb brick wall: 43%	42	7630	49724	4736
Flooring, Kota stone: 21.7%	46	7103	54460	0
Combination of the above pallette	32	8945	37884	16576
Exterior roof reflectance				
Roof, Exposed concrete	44	7366	52092	2368
Window to floor area				
WFA: 20 %	21	10392	24861	29599
WFA: 32 %	52	6314	61562	-7102

Loss Gain

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