Inside / Out: Daylight in Sustainable Urban Design Conference

Report of Contributions

https://indico.global/e/9808

Contribution ID: **1** Type: **Oral presentation**

Introduction

Saturday 11 March 2023 10:00 (15 minutes)

Keyword 1

Keyword 2

Keyword 3

Keyword 4

Keyword 5

Contact by email

Author: Prof. KLUMPNER, Hubert (ETH Zürich Chair of Architecture and Urban Design)

Presenter: Prof. KLUMPNER, Hubert (ETH Zürich Chair of Architecture and Urban Design)

Contribution ID: **2** Type: **Oral presentation**

Keynote:

Saturday 11 March 2023 10:15 (45 minutes)

Keyword 1

Keyword 2

Keyword 3

Keyword 4

Keyword 5

Contact by email

Presenter: MÜLLER, Robert (Bartenbach)

Contribution ID: **3** Type: **Oral presentation**

Experiencing (day)light patterns: insights from architecture and from nature

Saturday 11 March 2023 11:30 (45 minutes)

Keyword 1

Keyword 2

Keyword 3

Keyword 4

Keyword 5

Contact by email

Presenter: Dr CHAMILOTHORI, Kynthia (Eindhoven University of Technology, Human-Technology Interaction)

Track Classification: Inside Daylight

Contribution ID: **6** Type: **Oral presentation**

Podium discussion

Contribution ID: **7** Type: **not specified**

Discussion, questions and answers

Saturday 11 March 2023 16:15 (30 minutes)

Keyword 1

Keyword 2

Keyword 3

Keyword 4

Keyword 5

Contact by email

Presenters: Dr CHAMILOTHORI, Kynthia (Eindhoven University of Technology, Human-Technology Interaction); Mr MÜLLER, Robert (Bartenbach); Prof. KLUMPNER, Hubert (ETH Zürich Chair of Architecture and Urban Design); Prof. SCHLÜTER, Arno (ETH Zürich Chair of Architecture and Building Systems); WALCZAK, Michael; Dr GROBE, Lars Oliver

Contribution ID: **8** Type: **Oral presentation**

Conclusion

Saturday 11 March 2023 16:45 (15 minutes)

Presenter: Prof. KLUMPNER, Hubert (ETH Zürich Chair of Architecture and Urban Design)

Contribution ID: **9** Type: **Oral presentation**

Outlook Daylight in Sustainable Urban Design

Saturday 11 March 2023 17:00 (15 minutes)

Keyword 1

Keyword 2

Keyword 3

Keyword 4

Keyword 5

Contact by email

Presenter: Prof. SCHLÜTER, Arno (ETH Zürich Chair of Architecture and Building Systems)

Contribution ID: **13** Type: **Oral presentation**

Aperture-Based Daylight Modelling: Forging the Link Between Inside-Outside Daylight Evaluation

The process that leads to the initial conception of the shape, form and size of a building (i.e. massing) is usually the starting point of an architectural design: the building is designed from the *outside-in*. Commonly used guidelines refer to quantities such as the vertical sky component determined at a point on the building envelope. Similarly for sunlight, the evaluation is carried out at a point on the facade. Massing-stage daylight/sunlight evaluations are nearly always carried out as a matter of routine.

The design of the interior spaces is usually finalised after the massing-stage evaluation. The next step is to determine daylight/sunlight performance measures for the occupied spaces with windows/rooflights. In other words, an *inside-out* evaluation. Until relatively recently, the sole daylighting metric in common use was the daylight factor. In the last decade, metrics founded on climate-based daylight modelling (CBDM) have gained in popularity and are now encouraged by various guidelines and standards, e.g. the 2018 European Standard and the 2020 WELL Building Standard. Irrespective of the next-stage method (daylight factors or CBDM), the *inside-out* evaluation essentially begins from scratch. In short, there is no linkage between the methods used at the planning stage and those for building performance.

Aperture-Based daylight modelling (ABDM) is a new modelling schema to evaluate building apertures (or any planar surfaces on the building envelope) based on numerical measures of their connectedness to the sun, the sky and the view of the external environment. ABDM is founded on essentially geometrical principles, but nevertheless it can provide meaningful indicators of the daylight/sunlight potential of building apertures (or surfaces, e.g. PV panels). The evaluation of sunlight, skylight and view at the building aperture presents something of a paradigm shift compared to existing approaches. Although 'radical'in terms of conception and simplicity, ABDM offers the potential of seamless refinement to CBDM-type solutions. In other words, the (purely geometrical) ABDM metrics can be gradually 'climatised'to more realistically represent the prevailing sunlight and skylight conditions derived from localised weather files using CBDM.

The multiple goals of achieving sustainable development in the built environment whilst providing interior spaces that sustain and promote health and well-being, and doing so within the cost-constrained realities faced by developers, necessarily results in competing interests. One of the essential functions of planning is to reconcile the competing interests with the least possible compromise for all relevant stakeholders, not least the future occupants of those buildings. The increasing importance given to both the internal environment (e.g. occupant well-being) and the overall building performance (e.g. net zero) will, sooner or later, result in the realisation that current practice must somehow be upgraded to account for these factors at the earliest stages of design/planning. Aperture-based daylight modelling has the necessary properties to serve as the basis for the evaluation method to fulfil that need.

Keyword 1

Daylight

Keyword 2

Planning

Keyword 3

Daylight modelling

Keyword 4

Keyword 5

Contact by email

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Session Classification: Inside-out daylight

Track Classification: Inside-out daylight

Contribution ID: **15** Type: **Poster**

Daylight situation of a renovated apartment in different urban settings

Renovation of existing residential buildings is acknowledged as an important and effective measure to increase efficiency of the building stock and thus decreasing energy use and related GHG emissions. However, substituting the old windows with new, better insulating windows has an influence on daylight availability. Daylight and solar radiation have a well-known influence on human health, by regulating the circadian rhythm, mood and behavior, as well as synthesizing vitamin D. In such a perspective, windows are the building's most complex physical interface, as they are required to both allow satisfactory daylight penetration and view to the outdoors, but also limit the thermal exchange between the indoor space and the outdoor environment. This aspect is particularly critical where the winter conditions require well insulated buildings and high daylight penetration. The relationship between the thermal insulation, the visible transmittance, and the solar energy transmittance of glazing, with either clear or low emissivity glass panes, can be described with an asymptotic curve [4-6]. In practice, improving the thermal insulation of a glazing system will automatically lower its visible transmittance, which in turn has a negative influence on daylight availability and increases the use of electricity for indoor lighting [7-9].

The scope of this paper is to investigate the consequences on daylight when substituting existing windows (center-glass U-value 2.8 W/m2K) for new better performing windows (center-glass U-value 0.6 W/m2K) commonly used in the upgrading of residential buildings.
This work is based on the case study of an apartment room, which is located in three different urban settings (high, medium, low density). Three types of window solutions were analysed; type 1 is the old window situation, type 2 is the new window situation, type 3 is the new window situation with additional window on another wall of the room. All types are simulated in Radiance/Daysim [10]. The illuminance values are calculated on a grid located at 0.80 m above the floor level of the apartment. Daylight factors (DF) are calculated as well as Daylight Autonomy (DA), useful daylight autonomy (UDA), daylight saturation percentage (DSP), annual sunlight exposure (ASE), as well as cumulative daylight (lux hours). The type of tasks performed by the building users are modelled with three illuminance levels, 100 lux, 300 lux, and 500 lux) [11]. The combination of the parameters yields the scenarios presented a Table in the paper, and for which the above-mentioned indicators are calculated.

Daylighting analysis carried out in three residential apartment types before and after retrofitting windows show that such measures lead to a significant reduction in daylight autonomy when the tasks performed require 300 lux or more. Furthermore, the addition of extra insulation on the facade, and the resulting increase in wall thickness, also notably influences DA values negatively. Overall, it was found that these common retrofitting efforts most critically affect buildings in dense urban settings.
One solution, which includes an additional window installation, increases the daylight indicators. This has implications for designers of renovation cases in urban areas and should be taken into consideration.

Keyword 1

daylight autonomy

Keyword 2

renovation

Keyword 3

urban

Keyword 4

Keyword 5

Contact by email

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Author: HAASE, Matthias (ZHAW)

Presenter: HAASE, Matthias (ZHAW)

Session Classification: Posters

Track Classification: Inside Daylight

Contribution ID: **16** Type: **Oral presentation**

Sunlight Autonomy (SA) for building facades

Saturday 11 March 2023 15:15 (20 minutes)

Daylight has been a driver of urban and architectural form across climates. In the past century, metrics were introduced to describe performance such as minimum sunlight hours and the daylight factor. Means of assessment and related requirements were introduced in different contexts for sunlight/daylight. Some methods aimed to bridge the gap between inside-out such as the Vertical Sky Component (VSC) and the recent rethinking based on Aperture-based Daylight Modelling (ABDM). However, each daylighting method goes with its pros and cons. In addition, more advanced or combined simulations from research have overlooked the designer's perspective. For example, if the method is sufficiently understood by the designer, and/or actionable and therefore informs the design process. This study aims to introduce a new daylight metric for buildings as an early design stage methodology to bridge daylight inside/out –between buildings and urban developments. A traditional method like Sunlight (unit of hours) applies to both buildings and open spaces. Sunlight assessment can be time-consuming and has limitations when carried out on paper. Computation-based approaches and 3D models can support its effective use and reduce the time and errors of the process. Sunlight has also a higher versatility than other methods in terms of scope of the analysis, scale, geometrical complexity, and analysis period e.g., an hour, a day, season, year or user specified. Results can be presented cumulatively in hours, averaged, or as a percentage. Thus, the assessment can be easily understood by all stakeholders. In addition, sunlight can be used to design for the densification of cities, green spaces, and outdoor comfort provision. Case studies are illustrated by mapping results onto model geometry. Despite the versatility of sunlight, it also goes with uncertainty in interpretation for designers. As an improvement, simulations can be customized to a standard (e.g., EN 17037 Daylight in Buildings) with existing visual scripting tools such as Grasshopper. The three levels of performance (1.5, 3, and 4 hours) in EN 17037 can be used to derive spatial metrics for building performance. We propose a new metric called Sunlight Autonomy (SA) for building facades. SA can be defined as the percentage of façade area (m2) that is above a performance level e.g., 1.5 hours. Other ways to conceptualize SA on an annual basis can be a) the percentage of days that receive more than 1.5 hours of direct sun, or b) the percentage of time that direct sun hits the grid point. Then, the spatial SA (sSA) is the percentage of façade area above a defined threshold i.e., a) of hours/day or b) of time/daylight hours. We suggest that SA assessments on 3D models with the European Daylight Standard restrictions can reduce uncertainty and enhance the performance comparability of projects. It can also serve as a flexible and new evaluation method for designers and planning authorities. Further work should investigate more latitudes and urban typologies for recommendations of the SA metric.

Keyword 1

architectural design

Keyword 2

daylighting

Keyword 3

EN 17037

Keyword 4

buiding performance

Keyword 5

design metrics

Contact by email

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Presenter: DERVISHAJ, Arlind (KTH Royal Institute of Technology)

Session Classification: Inside-out daylight

Track Classification: Inside-out daylight

Contribution ID: **17** Type: **Poster**

Investigation and Development of Innovative Façade Design Strategies for Daylight Modulation in Multistorey Buildings

The building sector currently accounts for around 40% of global energy use and GHG emissions and there has been significant research in the recent decade in several engineering disciplines to upgrade building performance with the minimum disturbance to the building interior conditions. As countries race to build climate resilience, the shift from low-density suburban to high-density urban has recently emerged as an effective solution for a broad reduction in grid emission rates and fuel consumption. There are solid empirical studies that confirm the role of urban densification as a significant component of energy conservation transitions. A dense urban context, however, is also a source of sun shading and has a substantial impact on interior daylight access in buildings. To give a brighter spotlight to a building's adaptability to increasing urban density, this research intent is to investigate various passive envelope options for adding to the designer's palette to modulate daylighting access in mid-rise and high-rise buildings in a dense urban context. The building façade is the boundary layer for exterior environments and a regulator of interior microclimates. Envelope retrofits tended to rank better than energy-intensive upgrades in terms of carbon reduction per dollar spent, and innovative façade technologies have been undergoing continuous evolution and improvements in recent years. This research thus first seeks to identify effective design strategies and practical considerations related to the successful designs that demonstrate efforts to benefit from exterior climate conditions to provide adequate daylight in buildings. In this research, innovative design packages which include practical roadmaps of building fenestration renovation for better glazing, shading, and solar gaining as well as functional patterns of building enclosure designs for better interaction with the ambient environment are being explored for optimal daylight control in multistorey buildings. As the outcomes of the investigation, the research then proposes a framework on how to fundamentally promote daylighting efficiency and achieve the best outcome in buildings through deployable structural components that are directly applicable to the vast majority of the future global building stock.

Keyword 1

Innovative façade technologies

Keyword 2

Daylighting access modulation

Keyword 3

Urban densification

Keyword 4

Keyword 5

Contact by email

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Presenter: KHODAEI TEHRANI, Hanieh

Session Classification: Posters

Track Classification: Inside Daylight

Contribution ID: **18** Type: **Poster**

Daylighting analysis in gynaecological-obstetrics emergency rooms. Case study: Mendoza Metropolitan Area, Argentina

Decision-making at gynaecological emergency room is highly important and quality care is fundamental. Combinations of distinctive features in a patient result in the recognition of a disease, and visual cues are particularly prone to misinterpretation. Furthermore, fatigue and circadian disruption can have a negative impact on the clinic. Research on daylighting in hospital environments has focused on improving conditions for patients, and little progress has been made with regard to health care staff.

For this reason, the general objective of this research is to identify daylight-related barriers and facilitators, for visual performance, visual comfort, and health in health-care workers at gynaecological-obstetrics emergency rooms in maternity hospitals in the Metropolitan Area of Mendoza, Argentina. The proposed case-control methodology consists of five stages: (i) background research, (ii) analysis of barriers and facilitators, (iii) visual performance in context, (iv) proposal of ergonomic lighting indicators in hospital environments and (v) data analysis and conclusions of the evaluations carried out. The PhD thesis is progressing in the second stage, in which seven emergency rooms in hospitals of different morphological, levels of complexity and capacity of care were surveyed, with the aim of selecting representative cases. Despite one of the cases lacks daylighting, it was also included in the analysis due to the hierarchy of the institution within the healthcare system. The physical and photometric measurements were carried out using the PC-SRT protocol from January to August 2022 between 10.00 am and 12.30 pm. Then, national and international standards were checked in the most frequently used lighting scenario, and finally indoors daylight availability was calculated by means of Andrew Marsh's free web-based app "Dynamic Daylighting V2.0.0". We ran seasonal and annual simulations from 8 a.m. to 6 p.m., following the recommendations of the IES LM-83-12 standard. The resulting horizontal illuminance (Eh) levels at workstations did not meet the requirements of the national standard DR 351/79 and the international reference standard EN 12464-1&2: 2011.In examination rooms a general lighting of 500 lx and 1000 lx for the examination and treatment area is required according to the international standard. The measurement showed Eh values between 63-1043lx for the examination and treatment area. For writing, typing, reading, data processing tasks, Eh were recorded between 62-510lx. The dynamic daylight analysis was based on used Daylight Autonomy (DA 300lx), Spatial daylight autonomy (sDA300lx, 50% time) and Useful Daylight Illuminance - exceeded (UDI e >3000 lx). The calculated annual of DA 300 lx results ranged from 0%-72.54%, sDA 300lx, 50% time ranged from 0%-88.3% and UDI e ranged from 0%-6.59%. As a result for this stage, we selected for the further case-control study, four cases in which the percentages of daylight availability and inter-seasonal variability differed. In cities where clear skies predominate, as is the case in the province of Mendoza, solar radiation is an enormously usable resource, which motivates to do proposals to improve of daylighting performance at interior spaces.

Keyword 1

Daylighting

Keyword 2

Ginecological-obstetric ER

Keyword 3

Healthcare staff

Keyword 4

Environmental ergonomics

Keyword 5

Contact by email

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Presenter: Ms PAVIGLIANITI, Valeria Dana (INAHE- CONICET)

Session Classification: Posters

Track Classification: Inside Daylight

Contribution ID: **19** Type: **Oral presentation**

Delphi study for the development of an integrative lighting labeling system

Saturday 11 March 2023 13:45 (20 minutes)

This research seeks for indicators and methods of characterization, evaluation, certification and/or accreditation of integrative litgting for indoor workplaces. We carried out an online three-stage Delphi study to select descriptors and indicators of integrative lighting: (I) consensus of descriptors, (II) consensus of indicators, (III) weighting of descriptors and indicators. This paper presents the results of stages I and II, In stage I, we defined five dimensions of integrative lighting (i.e. Visual Performance, Visual Comfort, Sight, Control, Vitality) based on the Ergonomic Lighting Indicator (ELI) method. Based on a literature review, we proposed a set of descriptors, and then we invited lighting experts rated them in a five-point scale from "not important at all" to "very important". There was consensus when a descriptor was rated as "important" or "very important" by at least 75% of experts. Consented descriptors continued to stage II, where we classified them as (i) VISUAL/PHOTOMETRIC descriptors (i.e illuminance levels: luminance contrasts; occurrence and magnitude of physiological and discomfort glare; occupants' perception and opinions, daylighting, circadian lighting, complementary parameters of lighting, and lighting control and flexibility) or (ii) TEMPORAL/HUMAN FACTORS descriptors (i.e. age, preferences, task, and environment). In stage II, consensus required 50% of expert agreement.
Thirty-two experts participated in Stage I. For Visual Performance, four out of six descriptors exceeded the threshold. In Vista, two did not reach the threshold. All of the experts indicated the importance of flicker in Visual Comfort. For Vitality, the most important descriptor was stabilization of the circadian cycle. Finally in Control, only basic aspects of lighting control exceeded the threshold. Twenty-Three experts participated in Stage II. Regarding VISUAL/PHOTOMETRIC descriptors, there was a strong agreement in measuring at the specific plane of the visual task with a calibrated equipment to determine illuminance levels. In relation to user perceptions and opinions, there was consensus on using validated subjective instruments (i.e. questionnaires) and on the use of luminance meters for assessing both physiological and discomfort glare. In relation to TEMPORAL/HUMAN FACTORS, experts recommended measuring at specific time/s based on criteria under a dynamic lighting paradigm (i.e. repeated measurements). There was no consensus in recommending whether to perform lighting assessments at the current, the usual, or the worst lighting conditions. Finally, most experts recommended considering both the age and preferences of the occupants when assessing daylighting and illuminance levels, and only age when assessing disability glare. For the next stage, we plan to hold meetings with the experts who have participated in this work in order to learn their opinion regarding the analysis of the results presented in this paper.

Keyword 1

Indicators

Keyword 2

Integrative Lighting

Keyword 3

Environmental Assessment Method

Keyword 4

Keyword 5

Contact by email

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Presenter: Mr RODRIGUEZ, Roberto (CONICET)

Session Classification: Inside daylight

Track Classification: Inside Daylight

Contribution ID: **20** Type: **Oral presentation**

Design strategies, light as a tool

Saturday 11 March 2023 14:05 (20 minutes)

The design strategy of architect Zlatko Ugljen is explored through the analysis of three buildings. All three selected objects are sacral and are located in the territory of B&H. Through universality in approach and connecting tradition with a global language, a design language was created. The relationship with daylight plays a key role, both in the creation of volumes and in the formation of the atmosphere within them. The approach to this kind of design and the use of zenithal light can be traced through history. One of the most significant predecessors is the Roman Pantheon, or even old caves which were our first hiding places and places where we found the first drawings, and where the first mythology is born and respect for the supernatural started.

The first object we are analyzing is the Šerafudin's White Mosque in Visoko (43.985186, 18.180146). The mosque was designed in 1969, in the context of the then social conditions of the socialist state of Yugoslavia. Through a modern approach, a unique solution is created which differs from existing typologies (primarily Ottoman type). The design inspiration is sought at the story related to the Prophet Muhammad's stay in the cave. The architect creates an artificial concrete cave, shaped like a quarter of a compartment, with five zenithal openings in the roof. These openings are associated with the five daily prayers in Islam and are connected to the position of the sun during the day.

The first monastery and church in Plehane were destroyed in 1992, and the new complex consists of three parts: St. Mark church, monastery and cultural center (44.935738, 17.991670). The church is a landmark , positioned on the surrounding hill. In creating the volume of the object, the relationship to daylight and penetrations make a crucial influence on the design.. The cross vault, supported on four floating pillars, covers the church. The play of light and shadow that takes place inside the space contributes to the spatial drama.
The Catholic Church of St. Peter and Paul with its monastery is located in Tuzla (44.538138, 18.671971). The complex consists of three parts: the church, the monastery, and the oratory, which together form a unique spatial composition. In the central part, on the roof of the building, a small market has been formed, which can be accessed from all four sides. Questioning whether we can see the sacred object as a common space. The focus inside the church is on the altar and the space narrows towards it, and above the ceiling rises over the altar, illuminating it with zenithal light, creating a special ambient experience.

The author is constantly searching and entering undiscovered areas of architectural expression and paradigma. The guiding thread in his work is reliance on architectural heritage and its further modern transformed reinterpretation. Using elements rooted in the tradition and memory of the country where they are created and through different tools: light-dark relationship, geometric shapes, proportions and reading the context, his projects acquire a universal meaning and language.

Keyword 1

Design strategies

Keyword 2

light as a tool

Keyword 3

zenithal light

Keyword 4

design language

Keyword 5

Contact by email

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Presenter: Mr SIRČO, jasmin (Bosnia and Herzegovina)

Session Classification: Inside daylight

Track Classification: Inside Daylight

Contribution ID: **21** Type: **Poster**

A multiscale approach to 3D printed facades with bespoke thermo-optical properties

Daylighting and solar control are fundamental aspects of building design, especially for modern architecture marked by large glazed building envelopes. Visual and thermal comfort, heat gains, and, ultimately, energy consumption can be controlled with the correct management of solar penetration, which has become an essential element of facade design aimed at decarbonizing the construction sector. Solar control strategies need to account for the interactions of indoor and outdoor environments, which are specific to the building's location and use. The seasonal variation of solar irradiation, the dependence on the latitude and orientation of the site, and the different functional requirements of indoor spaces make solar control a challenging yet exciting task for designers and engineers.

This high level of control and customization required to tune the thermo-optical properties of building facades is not easy to achieve with traditional manufacturing techniques based on mass production and standardization. While the facade industry has been refining glazing and shading products toward increased performances and complexity of the components, the stringent need to consider embodied emissions of facades and their end-of-life has brought attention to radically new ways of designing and manufacturing facades. Among these, 3D printing holds promise for fabricating customized geometries with tailored thermo-optical properties. In particular, large-scale 3D printing of thermoplastic enables the fabrication of large-scale elements and control over finer geometrical features.

We investigate the potential of 3D-printed polymer facades with bespoke properties for thermo-optical control in buildings. Using a combination of numerical and experimental approaches, we observe that the tuning of facades'thermo-optical properties, such as visual transmission, reflection, haze, and solar heat gain coefficient, can be achieved by controlling geometrical features on multiple dimensional scales. At the material scale (nm), the choice of thermoplastic determines the base optical properties and can be altered during the printing process, where the material is melted, deposited, and cooled. On a larger scale (μm - mm), the characteristic layer resolution resulting from 3D printing also plays an important role in light transmission through 3D-printed components, resulting in variations of quantity (amount) and quality (directionality, diffraction) of transmitted light. At the component scale (cm - m), the facade geometry can be designed to respond to the specific site daylighting conditions (irradiation, orientation) and can be varied locally to reflect the requirement of the indoor spaces it encloses.

By combining geometrical and material control over multiple scales, we propose novel 3D-printed polymer facade components which exhibit locally tuned optical properties. Moreover, we propose characterization methods that can be used to assess the performance of such non-standard elements. These design and fabrication strategies hold promise for novel building components with reduced embodied and operational emissions.

Keyword 1

building facades

Keyword 2

3D-printing

Keyword 3

polymers

Keyword 4

optical properties

Keyword 5

thermal properties

Contact by email

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Presenter: PICCIONI, Valeria (ETH Zürich - Chair of Architecture and Building Systems)

Session Classification: Posters

Track Classification: Inside Daylight

Contribution ID: **22** Type: **Oral presentation**

An automated (day)light admission system based on a generic office model: from the simulation workflow to preliminary results

Saturday 11 March 2023 14:25 (20 minutes)

Automated daylight admission systems can adjust to varying lighting conditions and hence decrease the use of electrical lighting while improving user comfort. Several studies have shown in fact that manual control of shading systems often result in inadequate lighting conditions, as users tend to unregularly change the blind position throughout the day.

Among the reasons limiting the deployment of these systems, the unreliability in lighting level predictions and the difficulties in design and installation, linked notably to photosensors choice and calibration, are often cited in the literature. These systems typically require illuminance (and possibly luminance) sensors to be installed either indoors or outdoors. When only outdoors, simulation-based methods require a detailed geometric and photometric model of the space. Either way, both strategies often result in an excessive burden and cost for their commissioning in most buildings.

We present here a prototype of a data-driven (day)light admission system requiring only few geometric user inputs and weather data, hence easing its deployment. The system evaluates indoor illuminances in an office room equipped with external horizontal blinds, including sun and sky contributions, as well as the one from the luminaires.

The procedurally-generated geometrical 3D model of the scene includes a simple shoe-box model of the room and a simplified skyline, generated by retrieving terrain height data from an open API.

The daylight model is trained on RADIANCE-based simulations. Over 15'000 solar radiation measurements at a 15-minute resolution are used to model sky conditions for 3 representative orientations of the case-study building. We use the Perez All-weather sky model with diffuse and direct radiation monitored from a weather station installed on the building rooftop. Simulations of illuminance conditions for two virtual sensor points, corresponding to the best and worst desk locations within the room, are run using BSDF data for the fenestration system and 6 blind positions. The results of the simulations are used to train and test a Random Forest model, using a standard 70-30% split between the two sets.

The electric light model, based on previous work, predicts the illuminance contribution of electric lighting on the work-plane depending on the dimming status (0-100%) of the luminaires.

Both model are deployed on a RaspberryPi retrieving live data from the weather station via MQTT, and controlling the luminaires and blinds via KNX. Depending on the location of their desk, each user is assigned to the closest daylight and electric light virtual sensor. A user interface programmed in Node-RED allows the user to set their preferred illuminance range, while the automated control (which can be overridden) maximizes the use of daylight to stay within the range.

While the predictions are still to be compared with measurements, preliminary work shows an accuracy of 76% in the test set compared to the physically-simulated results, where predictions are scored differently depending whether they are within useful illuminance range or not. Future work includes training the model on a larger variety of room and window sizes to generalize it for all offices within the case-study building.

Keyword 1

lighting control system

Keyword 2

predictive model

Keyword 3

surrogate model

Keyword 4

Keyword 5

Contact by email

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Co-author: Dr KAEMPF, Jerome (Idiap Research Institute)

Presenter: PERONATO, Giuseppe (Idiap Research Institute)

Session Classification: Inside daylight

Track Classification: Inside Daylight

Contribution ID: **23** Type: **Oral presentation**

Intermediate Environments and Restorativeness: the role of view and daylight

BACKGROUND
The restorativeness potential of Intermediate Environments (IE) is the focus of this research. IE range from courtyards, arcades, balconies to window-seats, offering retreat to the interior and contact with the exterior. IE promote prospect and refuge, with shelter, safety, diverse controllable environmental conditions, adaptable sociability, and relaxation opportunities. Literature indicates that the restorative benefits of nature dominate Restorative Environments (RE) research, with fewer studies on built settings. With people spending a significant proportion of time indoors, and predominantly in cities, RE within buildings give opportunity to relieve stress, attention fatigue, and therefore warrants investigation.

METHODS
An initial pilot study was conducted at a cultural building –freely accessible to the public –in São Paulo, which includes IE of different spatial characteristics and environmental qualities. Mixed research methods were used, including qualitative participant interviews, and building environmental surveys. This methodology was expanded in two recent studies in São Paulo including: Perceived Stress Scale, participants heart-rate variability, galvanic skin response, eye-tracking, Restoration Outcome Scale, Prospect and Refuge questions, semi-structured qualitative questions, daylight, and thermal measurements.

DATA ANALYSIS AND INITIAL FINDINGS
Pilot study findings indicate that views, daylight, and sociability were the main IE characteristics contributing towards restorativeness. These were investigated in more detail in these recent studies. Pilot study findings are compared with recent studies'results, that include participant physiological data collection and eye tracking.

CONTRIBUTION AND NEXT STEPS
Although similar methodology has been employed in RE research, these are novel methods in the context of intermediate environments; results can demonstrate the value of such methods to inform subsequent IE research. For the next steps of the research, studies during different times of the day as well as within different seasons of the year are proposed, where the effects of daylight variation on restorativeness can be further explored.

Keyword 1

Intermediate Environments

Keyword 2

Restorative Environments

Keyword 3

Daylight

Keyword 4

View

Keyword 5

Eye Tracking

Contact by email

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Author: RUSSO, Filomena (University of Cambridge)

Presenter: RUSSO, Filomena (University of Cambridge)

Session Classification: Inside-out daylight

Track Classification: Inside-out daylight

Contribution ID: **24** Type: **Poster**

The challenge of urban densification in Sweden: three case-studies on daylight and sunlight access in urban level.

A chronic housing shortage combined with an increase of population in Sweden has led to a boom of new construction in the country´s cities. New developments are quickly being produced while spatial planning is still heavily reliant on traditional planning methods. Sweden constitutes an interesting case as densification is the preferred method to create more sustainable cities both financially and socially. The case for densification is also of course supported by a rapid increase in land prices. During the construction process, measures are taken to address the imminent climate change crisis but on the city scale the fast development affects the existing building stock not only in the energy use but in particular human health. With the Swedish climate's the long dark winters, sustainability on a city level is connected to the access to daylight and sunlight for both indoor and outdoor spaces. The Swedish building code provides only limited protection for daylight access as the guidelines have not been updated in some time. New advanced ways of analysis and the introduction of the EN standard however can provide sophisticated tools both to planning professionals and citizens alike to ensure that cities densify in a considered manner. Three Swedish case studies both for indoor but also for outdoor public spaces will be analysed and presented in order to discuss the ways we can move towards a more sustainable and inclusive spatial planning.

Keyword 1

densification

Keyword 2

daylight

Keyword 3

sunlight

Keyword 4

Keyword 5

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Author: STAMATAKI, Eftychia

Presenter: STAMATAKI, Eftychia

Session Classification: Posters

Track Classification: Inside-out daylight

Contribution ID: **25** Type: **Oral presentation**

Daylight in urban sports facilities / The dialogue of indoor and outdoor

Saturday 11 March 2023 15:35 (20 minutes)

Sports facilities have a crucial social, cultural, and morphological role in urbanization, in terms of indoor and outdoor spaces. The roots of sports go back to the Greek games. The purpose of these games was physical activity and mental cultivation and was associated with geographical conditions where sunshine and climate were operative. Over time daylight in sports started to become less involved in urban and architectural spaces due to the evolution of standardized rules and the need for establishing fair conditions. Regardless of indoor or outdoor sports, venues became more controlled spaces, and sports ended up being less of a game or recreational activity in daily life. These shifts have led to changes in the purpose of sports, and it started to become detached from natural conditions where daylight is one of the most important factors that generate this shift. This research, while putting forward the changes in the architectural and urban spaces for sports activities, reveals the importance of body activities in daily life for the well-being of people. As a result, it puts forward strategies that generate sports facilities with efficient daylight conditions.
Until the recent construction of indoor venues; sports were organized and established according to seasonal and geographic conditions. Sports were unconfined and liberated in terms of architectural space. With the effect of modernity, the festive and show purposes of bodily activities started to become more competition-oriented. This also found its reflection in the spatial organization of sports, and the specialization of space in sports became more dominant. Instead of natural and urban environments, spaces that are enclosed, marked, defined, measured, bounded, and increasingly standardized lead sports venues to become placeless. Competition-oriented body activities are equipped with such rules that it is impossible to participate in real, natural, and urban environments. Advances in building technology have developed in a way that allows the spaces arranged for body activities to be covered and moved into the buildings. That shifted the inside-outside perceptions where convertible spaces also became dominant. As a result of these developments, the effects of decreased daylight usage are twofold. First, its implications on human well-being, and second, the high energy consumption of artificial lighting that increases carbon emission rates.
In other words, since the body culture of the industrial society directed towards success is specialized, it shaped not only body cultural movements, but also the spaces where they take place. This situation has made sports venues unusable for anything other than sports and detached the relationship of body activities from urban environments. The need for movement and daylight in human well-being is inevitable. The daylight usage in sports venues is an important topic, nevertheless, sports as a recreational activity should be enhanced. Urban spaces where daylight is less controlled should be a necessary component of urbanization. This research renders different cultures and urban sports facilities to reflect on the future of urbanization and proposes strategies and classifications on daylight use with the aim of approaching carbon neutrality and healthy societies.

Keyword 1

sports facilities

Keyword 2

daylight

Keyword 3

artificial lighting

Keyword 4

mental cultivation

Keyword 5

sports

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Author: AKSU, Nesli Naz (METU / azaksu architects)

Presenter: AKSU, Nesli Naz (METU / azaksu architects)

Session Classification: Inside-out daylight

Track Classification: Inside-out daylight

Contribution ID: **26** Type: **Oral presentation**

Daylighting under Sky Conditions in an Urban Area

Saturday 11 March 2023 15:55 (20 minutes)

The correct use of natural lighting will depend on the study of the natural and urban conditions of a region. One of the main variables that determine the availability of natural light in a site is cloudiness, under each different type of condition of sky its dynamics will be different, identifying the frequency of this phenomenon and the predominant type of sky of a site, it is possible to generate better strategies for the use of the natural resource as a light resource.

This research focused on the study of the natural environment, the climatic elements that condition natural lighting in a site and its relationship with the existing urban environment of the Basin of Mexico.

The main variable that conditions this availability was studied, characterizing the different types of sky that occur in the Basin and from them generate strategies for use in the existing urban environment, since the characteristics and behavior of natural light outdoors will determine the final light availability indoors.

The methodology used for this characterization was divided into three important sources of information: on the one hand, the data generated in synoptic observatories carried out by a professional throughout the day on the state of the sky was gathered, on the other hand, it was systematized and processed. information from a TSI880 cloud camera installed on platforms of the Autonomous University of Mexico and finally satellite images acquired from the European satellite Sentinel 2 were processed by remote sensing, the 3 sources of information were compared to characterize the conditions of cloudy, partly cloudy and clear, yielding coefficients to represent the seasonal and diurnal frequency during a typical meteorological year.
The represented frequency was compared with the irradiance and horizontal illuminance variables of the site, which had an important correlation in the behavior of lighting levels with the presence of cloudiness.

The results of each one of them yielded different cloud cover coefficients, but within the range that characterizes each sky condition, therefore, satellite image processing could be used to determine and know the availability of illumination of a site, since synoptic observations are not always available in some cities and rural areas and there are very few daylight observation platforms with specialized equipment.

The visualization of cloud maps, in addition to their processing as images to obtain numerical data, is also important to know the distribution of greater or less cloud cover in a region, together with other urban variables represented in maps such as population and housing density, green areas, crowded areas or land uses, specific strategies can be generated. Knowing the frequency of cloud cover throughout the day and throughout the year will help us to know the availability of natural lighting in a region, whether it is direct or diffuse lighting, which should be used in different ways. These investigations help us to get to know cities better in order to take better advantage of natural features and generate key strategies in their planning and design.

Keyword 1

daylight design

Keyword 2

remote sensing

Keyword 3

sky conditions

Keyword 4

bioclimatic urbanism

Keyword 5

cloud cover

Contact by email

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Author: Prof. CRUZ, Raquel Yerani (National Autonomous University of Mexico)

Presenter: Prof. CRUZ, Raquel Yerani (National Autonomous University of Mexico)

Session Classification: Inside-out daylight

Track Classification: Inside-out daylight

Contribution ID: **27** Type: **Poster**

How can daylight analysis of the public realm contribute to mitigate urban heat island effects?

Dense urban spaces are strongly affected by the consequences of urban heat island effects and global warming. The pressing need for a sustainable urban metabolism necessitates the following query: To what extent can the understanding of micro-climate analysis in particular outdoor daylight studies drive an informed urban design approach in order mitigate the effect of urban heat islands in metropolitan areas?

Data-driven simulations can be a critical step towards achieving practical design suggestions for a sustainable urban environment. Computational simulation methods allow to perform micro-climate analysis in order to derive human comfort level. Through specific daylight analysis with metrics of shadow studies, sunlight intensity, view from sky or visual comfort, the impact on the urban environment is quantified.

The presented work examines an urban fragment of public realm in central London through different micro-climate analysis. This urban context is modelled in the Rhinoceros 3D computer-aided design (CAD) application and computationally simulated within Grasshopper (a visual programming language) with the help of corresponding Energy-plus weather files (.epw). The digital representation is programmed to not only measure factors like sunlight hours, illuminance, pavement temperature and radiation in kwh/m2 but also correlates the outcome with other figures that contribute to human comfort, such as a wind analysis through computational fluid dynamics (CFD) or thermal comfort according to the Universal Thermal Comfort Index (UTCI).

The quantified result visualised in 3D as a heat map projected on the surfaces of buildings and pavement depict the areas which are most affected by high radiation and wind movement. As such spaces are classified as the most uncomfortable zones for people to dwell in, it allows urban designers to develop specific spatial interventions to either add shading devices, harness solar radiation through PV-panels or populate the zone with landscape elements to cool it down.

The benefits of including such a performance-driven approach in early design stages can lead to support sustainable design interventions of outdoor spaces. The quantified values can be aligned to human comfort level which can e.g. identify the most suitable spaces for people to sit for a short or longer period or encourage people to spend more of their time in outdoor spaces in order to support health and well-being. Furthermore, it can help identify the best locations and orientations of renewable energy production sources, and inform suggestions for planning policies and governmental guidelines. The understanding of spatial character through micro-climate analysis generates a comprehensive approach within the design process which can be used as a baseline strategy to create spaces to increase well-being and improve urban ecosystem.

Keyword 1

Daylight Analysis

Keyword 2

Micro-Climate

Keyword 3

Urban Heat Island Effect

Keyword 4

Sustainable Urbanism

Keyword 5

Computational Simulation

Contact by email

I agree to get contacted by the conference organizers by email.

Author: FANKHAUSER, Nora

Presenter: FANKHAUSER, Nora

Session Classification: Posters

Track Classification: Inside-out daylight

Contribution ID: **28** Type: **Poster**

Presentation of a new research platform to explore the impact of daylight on humans

In 2021 an innovative new research platform to explore the basics, applied and clinical aspects of daylight on humans has been created. The "integrative Human Circadian Daylight Platform" (iHCDP) has the vision to improve general health, quality of life and living conditions across the live span by using daylight. For this purpose, the impact of daylight will be systematically assessed, and new tools, applications will be validated and implemented in the fields of vision science and ophthalmology, healthy ageing, and clinical practice. The platform aims to bring together researcher, light designers, architects, clinicians, and educators in the fields of daylight research, ophthalmology, vision science, and sleep- and circadian medicine to 1) explore basic research aspects of daylight; 2) explore circadian daylight solutions at the workplace and at home; 3) explore circadian health in the clinic. During the funding period (4 years), new tools for innovative daylight research will be developed and applied. A Circadian Data Hub will be created, and sustainable education and knowledge generation will be fostered. Finally, guidelines for evaluation and treating patients with circadian disorders and engagement in outreach for health professionals and the public at large will be developed. The iHCDP is directed by Prof. C. Cajochen and includes three research modules: Circadian Visual Neuroscience (led by Prof. Manuel Spitschan; Environmental Circadian Lighting (led by Dr Mirjam Münch); Circadian Health Clinic (led by Dr med. Corrado Garbazza).

Keyword 1

daylight

Keyword 2

non-visual effects

Keyword 3

well-being

Keyword 4

circadian

Keyword 5

physiology

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Authors: Dr MÜNCH, Mirjam (iHCDP); Prof. SPITSCHAN, Manuel (iHCDP); Dr GARBAZZA, Corrado (iHCDP); Dr RIES, Miriam (iHCDP); Prof. CAJOCHEN, Christian (iHCDP)

Presenter: Dr MÜNCH, Mirjam (iHCDP)

Session Classification: Posters

Track Classification: Inside Daylight

Contribution ID: **29** Type: **not specified**

Poster exhibition

Saturday 11 March 2023 10:00 (6 hours)

Posters addressing aspects of both tracks “inside daylight” and “insise - out daylight” will be displayed at the conference venue.

Session Classification: Posters