
3-5 September, Loughborough University, UK
2018 International Radiance Workshop

Programme

Monday, 3 September 2018

09:00–09:20 *Registration and breakfast*

09:20–09:30 *Welcome address*

09:30–10:00 Radiance Updates (*Greg Ward*)

10:00–10:30 Generating high-resolution BSDFs for the direct beam component (*Eleanor Lee, Taoning Wang, Lars Grobe, Greg Ward, Jan Wienold, David Geisler-Moroder*)

10:30–11:00 Towards a standardization of BSDF daylight system characterization (*David Geisler-Moroder*)

11:00–11:20 *Coffee break*

11:20–11:40 Recent case studies (*Santiago Torres*)

11:40–12:10 Predicting Visibility During the Modelling Phase+ (*Rob Shakespeare*)

12:10–12:30 Validation of HDR derived illuminance measurement in a conservation setting (*John Mardaljevic*)

12:30–13:30 *Lunch break*

13:30–13:50 An industry perspective on daylight calculations (*Helle Foldbjerg Rasmussen*)

13:50–14:20 Employing Radiance in Thermal Comfort simulations involving Complex Fenestrations (*Sarith Subramaniam, Sabine Hoffmann, Abolfazl Ganji, Eleanor Lee*)

14:20–14:40 Analysis of Reflected Glare: Electrochromic Glazing Performance in an Office Building (*Ahoo Malekafzali*)

14:40–15:00 Meteorological data for climate-based daylight modelling (*Eleonora Brembilla*)

15:00–15:30 *Coffee break*

15:30–15:50 Using daylight modelling to verify compliance with the WELL Building Standard (*Cosmin Ticleanu*)

15:50–16:10 Measuring and Modelling Spectral Composition of Equatorial Light (*Priji Balakrishnan and J. Alstan Jakubiec*)

16:10–16:40 Making simulations more colorful: Extension of gendaylit to create a colored sky (*Jan Wienold and Aicha Diakite*)

16:40–17:10 *Coffee break*

17:10–17:30 Automatic for the People: An Automated Build, Test, and Packaging system for Radiance (*Rob Guglielmetti*)

17:30–17:50 Two old studies that are somewhat interesting and probably worth sharing (*Andy McNeil*)

Tuesday, 4 September 2018

09:00–09:30 *Registration and breakfast*

09:30–10:00 *Labs tour*

10:00–10:30 Spatio-Temporal Visualisation of Reflections from Building Integrated Photovoltaics (*Roland Schregle, Christian Renken, Stephen Wittkopf*)

10:30–11:00 Towards Subjectivity in Annual Climate-Based Daylight Metrics (*J. Alstan Jakubiec*)

11:00–11:30 *Coffee break*

11:30–11:50 Enabling parametric modeling of non-coplanar shading systems (*Taoning Wang*)

11:50–12:10 Simulation-based workflows for the design of innovative textile shading systems (*Bruno Bueno*)

12:10–12:30 Validation of a geometrical model in Radiance for the design of textile shading devices (*Abel Sepulveda Luque*)

12:30–13:30 *Lunch break*

13:30–14:00 *Competition results and discussion*

14:00–14:20 Workflow for coupled daylight and energy simulations (*Tobias Skov Pedersen*)

14:20–14:40 Influence of Evalglare methods and parameters on discomfort glare prediction accuracy for daylighting (*Clotilde Pierson, Jan Wienold, Magali Bodart*)

14:40–15:00 Revit plugin for architects and urban designers to easily communicate between Radiance and Revit (*Majid Miri*)

15:00–15:30 *Coffee break*

15:30–15:50 A three-dimensional expression of light flow in colour using photon mapping (*Toshihide Okamoto and Nozomu Yohizawa*)

15:50–16:10 Exploring haze in privacy glass using both physical and virtual prototyping (*Alkyoni Papasifaki and David Barker*)

16:10–16:30 Shortwave studies with Radiance in the historic centre of Bayonne (*Antoine Bugeat, Benoit Beckers, Eduardo Fernández*)

16:30–16:50 Modeling of Prismatic Film Glazing with Climate-based Weather Data and Field Measurement (*Zhen Tian, Yaping Lei and Jacob C. Jonsson*)

16:50–17:10 *Coffee break*

17:10–17:30 Daylighting in the work of Louis Kahn: the Phillips Exeter Academy Library case study (*Michele Bruno*)

17:30–17:50 Daylighting performance assessment of shading devices concerning buildings aesthetic (*Ali F. Alajmi*)

17:50–18:10 Visual comfort with side-lit at restaurants under sunny climate (*Urtza Uriarte*)

Monday 3rd September	
9:00	Breakfast & Registration
	Welcome
9:30	Greg Ward
10:00	Eleanor Lee
10:30	David Geisler-Moroder
11:00	Coffee Break
	Santiago Torres
11:30	Rob Shakespeare
12:00	John Mardaljevic
12:30 13:30	Lunch Break
13:30	Helle Foldbjerg Rasmussen
14:00	Sarith Subramaniam
	Ahoo Malekafzali
14:30	Eleonora Brembilla
15:00	Coffee Break
15:30	Cosmin Ticleanu
	Priji Balakrishnan
16:00	Jan Wienold Aicha Diakite
16:30	Coffee Break
17:00	Rob Guglielmetti
17:30	Andy McNeil
18:00 18:30	Special Session
19:00	Dinner at Burleigh Court

Tuesday 4th September	
9:00	Breakfast & Registration
9:30	Labs tour
10:00	Roland Schregle
10:30	Alstan Jakubiec
11:00	Coffee Break
11:30	Taoning Wang
	Bruno Bueno
12:00	Abel Sepulveda Luque
12:30 13:30	Lunch Break
13:30	Competition results and discussion
14:00	Tobias Skov Pedersen
	Clotilde Pierson
14:30	Majid Miri
15:00	Coffee Break
15:30	Toshihide Okamoto
	Aliki Papasifaki
16:00	Antoine Bugeat
16:30	Zhen Tian
	Coffee Break
17:00	Michele Bruno
17:30	Ali Alajmi
	Urtza Uriarte
18:00	Workshop closure

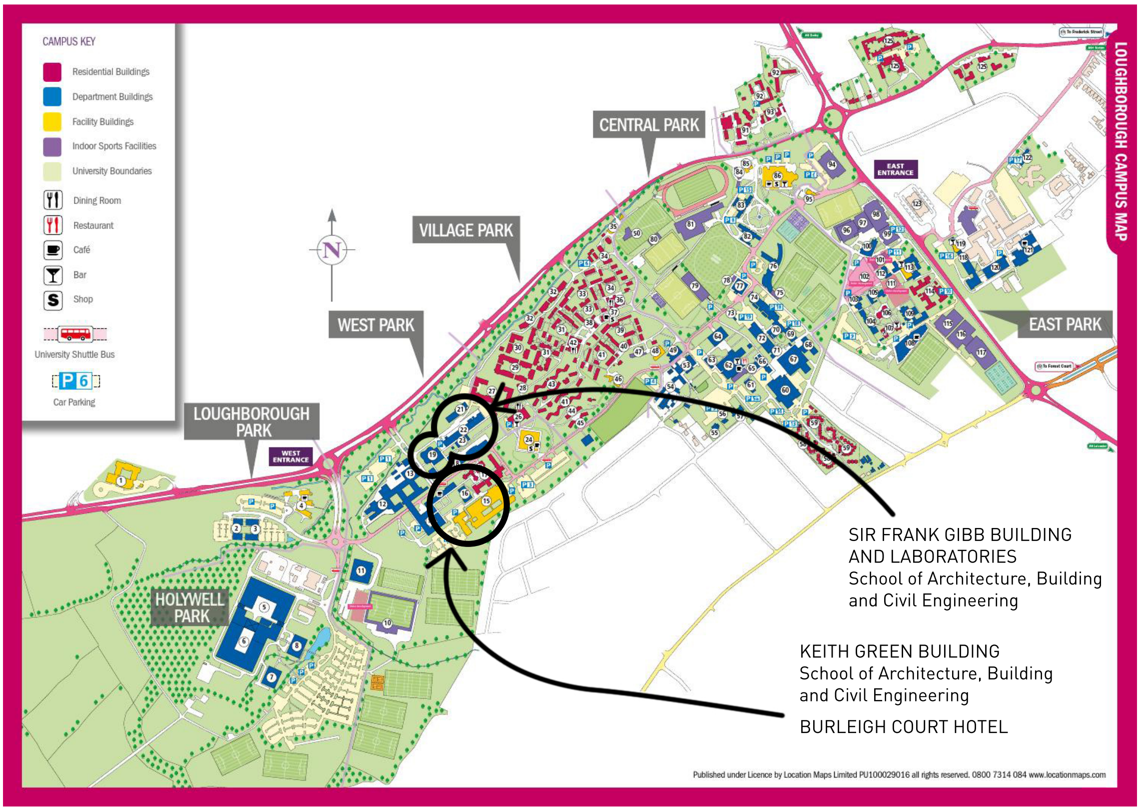
Wednesday 5th September	
9:00	Breakfast & Registration
9:30 10:00	Tutorial 1 Ambient calculation crash-course
10:30	Tutorial 2 The 4 Component Method
11:00	Coffee Break
11:30 12:00	Tutorial 3 Autonomous DSLR Setup for HDR Capture
12:30 13:30	Lunch Break
13:30 14:00 14:30	An Introduction to Honeybee for the Radiance User Part I
15:00	Coffee Break
15:30 16:00 16:30	An Introduction to Honeybee for the Radiance User Part II
17:00	Tutorials closure

Campus map

The workshop is taking place in the Keith Green Building (16), at the West end of Loughborough University Campus. The Keith Green Building is home to the new faculty of Architecture. The rest of the offices for staff of the School of Architecture, Building and Civil Engineering is located in the Sir Frank Gibb Building (19). All the School's laboratories (22) are located just beside the main building.

The entrance to Burleigh Court Hotel (15), where the conference dinner will take place on the evening of the 3rd September, is very close to the Keith Green Building.

For any queries before, during, and after the workshop, please contact Eleonora Brembilla (E.Brembilla@lboro.ac.uk) or John Mardaljevic (J.Mardaljevic@lboro.ac.uk).



To connect to the University WiFi during the week 03/09/2018–10/09/2018 please select the **imago** network, insert your details, and insert the code **1732**.

Abstracts booklet

Monday, 3 September 2018

Radiance Updates

09:30–10:00

Greg Ward

Anyhere Software, CA, USA

Generating high-resolution BSDFs for the direct beam component

10:00–10:30

Eleanor Lee[1], Taoning Wang[1], Lars Grobe[2], Greg Ward[3], Jan Wienold[4], David Geisler-Moroder[5]

[1]Lawrence Berkeley National Laboratory, CA, USA
[2]Hochschule Luzern (HSLU), Lucerne, Switzerland
[3]Anyhere Software, CA, USA
[4]EPFL, Lausanne, Switzerland
[5]Bartenbach, Innsbruck, Austria

Low-resolution BSDF data averages flux over a large solid angle, which reduces intensity and can lead to significantly less conservative estimates of glare and thermal discomfort from direct sunlight. High resolution BSDF data are needed to capture the details of peak transmission and reflection. We discuss work to date, conducted in collaboration with Bartenbach, HSLU, and EPFL, to develop and validate a standard method for generating high-res BSDFs. A sample roller shade fabric was used in this iterative investigatory process.

Towards a standardization of BSDF daylight system characterization

10:30–11:00

David Geisler-Moroder

Bartenbach, Innsbruck, Austria

Recent case studies

11:20–11:40

Santiago Torres

Arup Lighting, London, UK

The presentation will look at Radiance examples that involved special analysis or calculation methods. Examples include circadian analysis, simulation of fog conditions, and controlled sunlight entering a museum gallery.

Predicting Visibility During the Modelling Phase+

11:40–12:10

Rob Shakespeare

Shakespeare Lighting Design, IN, USA

Validation of HDR derived illuminance measurement in a conservation setting

12:10–12:30

John Mardaljevic

Loughborough University, Loughborough, UK

An industry perspective on daylight calculations

13:30–13:50

Helle Foldbjerg Rasmussen

MicroShade A/S, Taastrup, Denmark

Climate Based Daylight Modelling (CBDM) has been known for more than 10 years and it is now moving into standards and building legislation creating a demand for "easy to use" software for designers. There is a strong need in the market for software that can not only do easy and fast daylight calculation, but also link to thermal indoor climate and energy calculation. The entire building need to be optimized to meet the tightening energy demands. Here the daylight openings are the main deciding parameter and second thereafter is the solar shading. Therefore, the software needs to be able to easily take a range of different solar shading technologies into account using the same assumptions for both daylight and thermal indoor climate simulations.

As a manufacture of a complex fenestration system facing the above challenge we would like to share the difficulties that we and our customers run into when we try to simulate buildings taking both daylight, indoor climate and view out into account. A case study showing how simulations with different types of solar shadings can be linked together between simulation software will be shown.

Employing Radiance in Thermal Comfort simulations involving Complex Fenestrations

13:50–14:20

Sarith Subramaniam[1], Sabine Hoffmann[1], Abolfazl Ganji[1], Eleanor Lee[2]

[1]TU Kaiserslautern, Germany

[2]Lawrence Berkeley National Laboratory, Berkeley, USA

Analysis of Reflected Glare: Electrochromic Glazing Performance in an Office Building

14:20–14:40

Ahoo Malekafzali

SageGlass, Faribault, MN, USA

Meteorological data for climate-based daylight modelling

14:40–15:00

Eleonora Brembilla

Loughborough University, Loughborough, UK

Climate-based daylight modelling (CBDM) is the prediction of any luminous quantity (illuminance and/or luminance) using realistic sun and sky conditions derived from standardised climate data. CBDM evaluations are usually carried out for a full year at a time-step of an hour or less in order to capture the daily and seasonal dynamics of natural daylight. Developed in the late 1990s, CBDM steadily gained traction – first in the research community, closely followed by some of the more forward-thinking practitioners.

Preliminary findings from the Weather Data for Daylight Modelling (WDDM) project will be presented. The project seeks to address the applicability of generally available climate (or weather) files specifically for the purpose of predicting annual measures of luminous quantities using CBDM, and it is funded by the Chartered Institution of Building Services Engineers (CIBSE). Radiometric and photometric data are generally derived from other synoptic variables, potentially affecting the accuracy of final CBDM results. New approaches to provide irradiance and illuminance data for standard climate files are being investigated, and will inform the next generation of CIBSE climate files.

Using daylight modelling to verify compliance with the WELL Building Standard

15:30–15:50

Cosmin Ticleanu

Building Research Establishment, Watford, UK

The WELL Building Standard focuses exclusively on the health and wellbeing of building occupants. Two versions are currently in use (WELL v1 introduced in October 2014, and WELL v2 released in June 2018). Both versions address various wellness concepts meant to improve occupant health and wellbeing. The Light concept promotes optimal light exposure and improved visual, mental and biological health through minimised circadian phase disruption and better sleep quality, mood and productivity.

This paper discusses the WELL Light concept in both WELL v1 and WELL v2 with an emphasis on the criteria that require the use of climate-based daylight modelling (CBDM). This is illustrated through a combination of computer modelling and *in situ* measurements undertaken in an office space as part of a larger BRE research on biophilic office design and potential impacts on occupant health and wellbeing. Spatial daylight autonomy and annual sunlight exposure are evaluated and compared with WELL v1 and WELL v2 criteria. Exposure to circadian light as required by WELL v1 (i.e. including daylight between 9am and 1pm every day of the year) is also assessed through additional computer modelling and in situ measurements of illuminance and spectral power distribution in a vertical plane at occupants eyes.

The results of the study are used to discuss compliance with CBDM related criteria in both WELL v1 and WELL v2, and to highlight areas that may potentially need further consideration in future versions of the WELL Building Standard.

Measuring and Modelling Spectral Composition of Equatorial Light

15:50–16:10

Priji Balakrishnan and J. Alstan Jakubiec

Singapore University of Technology and Design, Singapore

Colours that surround us are not just the result of surface properties, rather the interplay between the spectral composition of illuminating light and spectrally specific surface reflectances. Spectral composition of daylight varies with time and is dependent on solar position, weather, atmospheric conditions, view direction and ground reflectance. Despite the temporal and spatial variation of daylight spectral composition, daylight simulation platforms most commonly use equal energy sky models such as the ideal CIE or all-weather Perez model skies that lack spectral and colorimetric information.

In this presentation, the authors would like to compare the results and challenges of using two Radiance based multi-spectral simulation platforms – LARK and ALFA. LARK is based on the N-step method (where the spectrum is divided into N consecutive steps and simulations carried out in N- channels rather than the standard three channels (RGB)) and can be run using measured spectral power distribution of the sky. Alternatively, ALFA is based on pre-computed coloured sky model generated using libRadtran (an atmospheric radiative transfer library). The comparisons are demonstrated using three complex urban scenes with three different materiality – plaster facades, vegetation and glass facades – under different sky conditions.

Making simulations more colorful: Extension of gendaylit to create a colored sky

16:10–16:40

Jan Wienold[1] and Aicha Diakite[2]

[1]EPFL, Lausanne, Switzerland

[2]TU Berlin, Berlin, Germany

Based on spectral measurements of 145 skypatches, collected at the TU-Berlin over more than 2 years, a spectral sky model was developed. It uses the relation $CCT = f(luminance)$ and the Perez sky luminance distribution. In a combined presentation we will show results of the measurement, the developed model and its implementation into the gendaylit-tool. We will also show some example renderings using different sky conditions.

Automatic for the People: An Automated Build, Test, and Packaging system for Radiance

17:10–17:30

Rob Guglielmetti

National Renewable Energy Laboratory, Golden, CO, USA
Luminous Bits, LLC, Boulder, CO, USA

For decades, the price of admission to the world of lighting simulation with Radiance was learning how to compile software and administer a Unix workstation, and left Windows users dependent on the occasional availability of Windows executables – often years out of step with the continual additions to the Radiance source code. In 2010, NREL's OpenStudio project began to offer Radiance support and with that, the need for current cross-platform Radiance installers arose. The OpenStudio team implemented a CMake build system in the Radiance source code years ago but recently took that to the next level, building a continuous integration (CI) platform around the Radiance. We will present the thought process behind this evolution and NREL's implementation of Radiance CI with Cmake, GitHub, and GitLab CI.

Two old studies that are somewhat interesting and probably worth sharing

17:30–17:50

Andy McNeil

Halio, Hayward, CA, USA

Part 1: A model of manual control for a single shade in a single context.

Part 2: Estimating annual output and optimizing the grouping of PV panels for a large and unusual rooftop PV installation.

Tuesday, 4 September 2018

Spatio-Temporal Visualisation of Reflections from Building Integrated Photovoltaics

10:00–10:30

Roland Schregle, Christian Renken, Stephen Wittkopf

Lucerne University of Applied Sciences and Arts (Hochschule Luzern), Lucerne, Switzerland
CR Energie GmbH, Collombey, Switzerland

We present a computational workflow using annual daylight simulation and image-based postprocessing to visualise cumulative annual irradiance and glare duration on the built environment due to reflections from building integrated photovoltaics. The annual daylight simulation considers reflections from measured BSDFs of proposed PV materials. The postprocessing includes a spatio-temporal feature detection to identify sustained glare duration based on recommended thresholds. We demonstrate this workflow with a case-study of a proposed PV roof retrofit for a church in Lucerne, Switzerland.

Towards Subjectivity in Annual Climate-Based Daylight Metrics

10:30–11:00

J. Alstan Jakubiec

Singapore University of Technology and Design, Singapore

This presentation continues to expand knowledge of the impact of light on human perception by relating climate-based daylighting metrics to long-term occupant perceptions of lighting quality. The results are based on a novel post-occupancy evaluation of 543 occupants in 10 office buildings located in Singapore. By taking instantaneous measurements, collecting subjective occupant data from surveys and calibrating lighting models for each building, for the first-time annual lighting calculations that people have experienced can be correlated to subjective responses. The aim of the exploration of the collected data is to understand desirable and undesirable subjective lighting qualities in spaces that can be derived from current annual luminance and illuminance-based daylight prediction workflows.

Enabling parametric modeling of non-coplanar shading systems

11:30–11:50

Taoning Wang

Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Non-coplanar shading (NCPS) systems such as overhangs and awnings can significantly reduce solar heat gains and preserve daylight in buildings, if designed properly. A matrix algebraic based simulation method was proposed to enable efficient and accurate parametric analysis of the thermal and daylight performance of NCPS systems. This talk presents the final outcomes from the field validation, showing that the proposed method can accurately capture the flux transfer properties of a NCPS system. The talk will then demonstrate the workflow of generating the NCPS BSDF, combining it with other BSDFs (e.g., BSDF representing a coplanar window and shading system), and then using the combined BSDF in an energy simulation.

Simulation-based workflows for the design of innovative textile shading systems

11:50–12:10

Bruno Bueno

Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany

Advances in the manufacture of textiles allow a great flexibility in the design of yarn structures for different applications. This study presents different simulation-based workflows for the design of textiles with enhanced functionality for solar shading applications. Two types of design workflows are identified depending on whether they aim to fulfil requirements at building level or at component level. A new hybrid design workflow is presented. In the hybrid workflow, the requirements of the shading system at component level are determined by an analysis of a case study at building level. The analysis of the case study consists of a parametric study with dynamic building simulations, evaluated through a selected set of metrics. The hybrid workflow allows a case-specific design of textile shading systems.

Validation of a geometrical model in Radiance for the design of textile shading devices

12:10–12:30

Abel Sepulveda Luque

Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany

In this study, a Radiance geometrical model of angle-selective solar shading textiles is developed. The goal is to be able to generate BSDF data from different textile geometries to feed building simulation programs, such as Fener and EnergyPlus, without having to manufacture and optically measure all possible design alternatives. In this study, BSDF data from different geometrical models are compared with optical measurements from a scanning photogoniometer (pab-pgII). A sensitivity analysis is carried out to identify possible sources of discrepancies between simulations and measurements. Radiance simulation parameters and uncertainties in the description of the system (geometry, surface properties, etc.) are analyzed. The results show that the most critical parameter is the geometry definition itself. As a result, a realistic geometrical modeling of the complex textile structure produces an acceptable agreement between simulations and measurements for different geometries. For textiles with marked cut-off angles, the agreement fails for polar angles next to the cut-off angle, presumably due to the poor angular resolution of the Klems patches.

Workflow for coupled daylight and energy simulations

14:00–14:20

Tobias Skov Pedersen

MicroShade A/S, Taastrup, Denmark

In the pursuit of tools to provide faster and more accurate daylight and energy simulations, a variety of CBDM tools has been examined. It has been sought to develop a fast and accurate, parametric workflow to perform coupled daylight and energy simulations, relying on the same assumptions for both.

As a part of my BSc thesis, from Technical University of Denmark, the Five-Phase Method has been established as very well suited to meet the objectives of speed and accuracy, due to its parametric nature and more accurate modelling of direct solar contribution. Simultaneously the method relies on the BSDF format to portray the IGU properties, which serves as a common assumption for the daylight and energy simulation.

By displaying the great benefits of using coupled daylight and energy simulations, we hope to inspire more consulting engineers to use CBDM in their daily work.

Influence of Evalglare methods and parameters on discomfort glare prediction accuracy for daylighting

14:20–
14:40

Clotilde Pierson[1], Jan Wienold[2], Magali Bodart[1]

[1]UCL, Louvain-la-Neuve, Belgium

[2]EPFL, Lausanne, Switzerland

In the field of discomfort glare nowadays, most studies aim to evaluate visual discomfort by using Evalglare to derive glare metrics, such as DGP and DGI. Evalglare is a Radiance tool, that detects glare sources in an HDR image and calculates discomfort glare metrics using the detected glare sources. Usually, researchers use default/recommended methods and parameters in Evalglare, without checking if the glare sources detected by Evalglare are reasonable and the method/parameters applied are the most appropriate for their dataset. In this study, the 3 different methods implemented in Evalglare (factor method, threshold method, and task area factor method) to detect glare sources in an HDR image were applied along with different options and parameters (different thresholds and factors, but also the use or not of the smooth option, of different search radius, etc.) to two datasets of around 150 HDR images (each HDR image corresponding to one subjective glare evaluation). The accuracy of the discomfort glare prediction of 5 glare metrics (DGP, DGI, CGI, DGImod, UGP) derived from these HDR images using a total of 63 different method-parameters combinations in Evalglare was evaluated by comparing the metrics values to the subjective glare ratings. Results show that the 2 datasets used (one laboratory study dataset and one field study dataset) behave differently with the methods and parameters in Evalglare. Moreover, the accuracy of discomfort glare prediction can change significantly according to the method and parameters chosen. Recommendations on the choice of Evalglare parameters and methods when calculating discomfort glare metrics from HDR images are provided in accordance to the type of data to analyse. The full paper can be found at www.mdpi.com/2075-5309/8/8/94.

Revit plugin for architects and urban designers to easily communicate between Radiance and Revit

14:40–
15:00

Majid Miri

Sweco Architects, Stockholm, Sweden

Including daylighting strategies early in the building and urban design process is crucial when it comes to the compliance of environmental certification systems or when the aim is to simply create a building with sufficient access to natural light. Therefore, in this presentation we are going to introduce a new tool that can help architects or urban designers/planners to evaluate daylight condition of exterior or interior spaces by calculating different daylight metrics in different design stages.

In the continuation of what I presented last year in Radiance conference that was about a Dynamo node to export the model from Revit to Radiance, and regarding some memory issues and other problems that Dynamo has for more complex models, I am going to present a new tool/plugin for Revit that has some more interface for handling the materials, Radiance SKY, RAD and RIF files and I have developed it recently. In this

interface, we can export the model based on the categories in Revit, and its 3d views specified inside the Revit. Moreover, there is an additional feature to export the Mass and Generic model to OpenFoam program with a possibility to do some adjustment for the wind analysis calculation. So, the main goal of this plugin is to give a better possibility for architects and even urban designers to evaluate their design in every stages in their design to the end.

A three-dimensional expression of light flow in colour using photon mapping

15:30–15:50

Toshihide Okamoto and Nozomu Yohizawa

Tokyo University of Science, Tokyo, Japan

Considering light distribution in space is one of the important aspects in the process of architectural design. In the present situation illuminance/luminance distribution on some two-dimensional surfaces is the most useful information for describing lighting environment, however, if we can visualize the flow of light in space three-dimensionally, it will be helpful for designers to easily grasp the rough image of the light field which surrounds people in the space, and it will make it possible to advance the human centered lighting design. In the previous report in the Radiance workshop in 2016, we showed a method to visualize the flow of photons and clarified that the density of photons had a positive correlation with scalar illuminance. In this presentation, we will report how to link the photon distribution to the absolute value of scalar illuminance, and a new method to depict the photon flow in RGB colour separately. This expression method will help to convey colour distribution in space.

In a simple room with an opening illuminated by daylight, a photon port was set at the window, and unit spherical surfaces made of antimatter material in Radiance were arranged in a grid in the room, and the emitted photons were stored in those virtual spheres. The scalar illuminance is defined as the average illuminance on an infinitesimal spherical surface at a certain point, and was calculated based on the number of photons and their radiant flux extracted from the mkpmap command script. For the expression of photon flow in RGB colour separately, monochromatic light and material per RGB respectively was used for calculation for photon distribution.

We applied this visualizing method to “Villa Müller” by architect Adolf Loos in the early 20th century. This is one of the most famous architecture designed by the idea of “Raumplan”. In architectural design, two-dimensional horizontal planes are generally created at first, then spatialized by expanding them in vertical direction, whereas in “Raumplan” process a sequence of spaces is drawn in three-dimensions from the beginning. “Villa Müller” has not only the complex composition of the rooms, but also the wide variety of materials. We could see the coloured light gathering in the room with vivid green/blue surfaces, and overflowing to the next room.

In the future, further experiments will be conducted to clarify the influence of colour distribution on the perceptual impression of architectural spaces, and we would like to apply those tools to human centered design.

Exploring haze in privacy glass using both physical and virtual prototyping

15:50–16:10

Alkyoni Papasifaki and David Barker

Elementa Consulting, London, UK

Optical haze is a common issue for privacy glass products while they are in their transparent state, particularly when viewed from oblique angles. When haze is measured in accordance with standards such as ASTM D 1003, only normal incidence transmission is addressed. The presentation will cover Elementa Consulting's work to investigate haze and develop appropriate Radiance material definitions:

- HDR photography of five privacy glass products at various angles of observation
- Calibration of Radiance material definitions using glass and trans primitives
- Visualisation of final material definitions within a representative scene

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Shortwave studies with Radiance in the historic centre of Bayonne

16:10–16:30

Antoine Bugeat[1], Benoit Beckers[1], Eduardo Fernández[2]

[1]Urban Physics Joint Laboratory, Université de Pau et des Pays de l'Adour, I2S UPPA, Anglet, France

[2]Instituto de Computación, Universidad de la República, Montevideo, Uruguay

When simulating the energy performance of a building, precise modelling of the building and its environment is essential to obtain usable results. The environment has an impact on the performance of the building and conversely the building itself has an impact on the performance of the surrounding buildings. Therefore, the problem must be addressed with this duality in mind. Two studies in different cases in the historic centre of Bayonne are presented here: Solar gains on a street, and daylight inside a light well.

- A long-term objective of the solar gains study is to simulate thermograms on an urban scale in order to understand and anticipate the phenomena that occur there. Since solar radiation plays an important role in this type of study, it is necessary to simulate it with precision while keeping reasonable calculation times. The first results obtained from the simulation of an existing street in Bayonne are presented here.
- For the daylighting study, we will move from an outdoor public space, the street, to a light well, a private space inside one of the buildings of this street. The objective is to improve visual comfort. The light well has to bring a maximum of light into the darker rooms. Architectural alternatives have been tested and evaluated based on UDI studies. As perceiving a small amount of daylight can be very pleasant in an apartment and is not negligible, the minimum threshold was chosen at 100 lux.

For both cases, the inter-reflections that occur between the different surfaces represent an important part of the total radiation. RADIANCE can model all types of materials (BRDF, BRTDfunc, glass, plastic...) and handle reflections accurately. The modification of the components of a facade can then have a preponderant impact, which may be positive or negative. Similarly, coarse considerations of the characteristics of materials can lead to significant approximations. This study will be an opportunity to review the different methods to model the surfaces of both environments as well as the impact that certain hypotheses can have on the results.

Modeling of Prismatic Film Glazing with Climate-based Weather Data and Field Measurement

16:30–16:50

Zhen Tian[1], Yaping Lei[2] and Jacob C. Jonsson[3]

[1]School of Architecture, Soochow University, Suzhou, China
[2]Suzhou Institute of Building Science Group, Suzhou, China
[3]Lawrence Berkeley National Laboratory, US

Daylighting in the work of Louis Kahn: the Phillips Exeter Academy Library case study

17:10–17:30

Michele Bruno

Kalisode network, Sweden

The object of this research is one of the most outstanding examples of library ever built: the Phillips Exeter Academy Library, designed by Louis I. Kahn in Exeter, NH, USA, during the years 1965-71.

During this talk, the complex library light-apparatus will be described. It is composed of three different mechanisms: the core with its 6 floors void, the shell with its wooden cladding and the rooftop with its crowning element.

With the help of different annual metrics, luminance and illuminance values and DGP, the technical value of a vast array of choices which Kahn did only with the support of physical models, constant observation, a longterm experience and a variety of rules-of-thumb will become clearer. A focus on a skylight solution will open a parallel between this and a similar result obtained by the architect on his last project (the Yale centre for British Art).

Daylighting performance assessment of shading devices concerning buildings aesthetic

17:30–17:50

Ali F. Alajmi

Mechanical Engineering Department, College of Technological Studies, PAAET, Kuwait

Buildings consume about 40% of the annual world energy and 70% of the annual generated energy in hot climate countries. Windows with its components such as glazing material, frame and internal and external shadings play a major role for energy transfer through windows and for harvesting daylighting. Thus, the main objectives of this study are to minimize the heat transfer through a window in summer as well as to maximize daylighting availability within a space in a hot climate.

The main types of windows' shading (overhang/sided-fins, louvers, and simple overhang) for the main orientations (East, West, North, and South) have been optimized. The manipulated design parameters were overhang projection (limited to half of the window height), inclination (maximum 45° from horizontal), and sided-fins projection (limited to the half of window width). An evolutionary optimization algorithm (Genetic Algorithm) and building simulation program (EnergyPlus) were linked to search for the optimum solutions.

The findings showed a saving, for instance, in east orientation 27, 25, and 24% of the overhang/sided-fins, louvers, and simple overhang respectively. Interestingly, there were several best solutions, since GA is a population-based algorithm; all other solutions have similar thermal performance within 3% differences. Therefore, to select among the optimum energy efficient solutions, both illuminance and annual daylighting assessments of Daylight Autonomy (sDA), Annual sunlight exposure (ASE), and Useful Daylight Illuminance (UDI) were implemented. In the case of the East orientation of the studied office, both assessment (seasonal and annual) showed that the louvers shadings performed the best. It showed a less risk to visual discomfort as interpreted by the ASE assessment and consequently has a better UDI than the others shading types. In conclusion, the architect can select optimum efficient shading devices that keep the building's aesthetic to their preferences with less sacrifices of shading energy efficiency.

Visual comfort with side-lit at restaurants under sunny climate

17:50–18:10

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This work deals with visual comfort with side-lit at restaurants under sunny climates. It has been detected that there are some daylight controlling problems in hotel industry. Lighting and out view requirements are not balanced. Modelling a virtual restaurant prototype at Barcelona, window combined by complex fenestration system facade is proposed to compare with highly glazed facade. Simulation by Radiance is chosen for assess daylight glare probability and daylight autonomy indexes. Evalglare with DIVA is used to obtain daylight glare probability and Three-Phase Method (and Five-Phase Method) is used to obtain daylight autonomy. Three workplanes as down, front and out view from facade adjacent point of view are selected to evaluate luminance distribution and a horizontal workplane along the space is selected to test illuminance distribution. The results show that the mean daylight glare probability of window combined by complex fenestration system facade is lower in 18% than highly glazed facade. Daylight autonomy of window combined by complex fenestration system facade is slightly lower in 5% than highly glazed facade. Otherwise, transition workplanes and out view as third rest workplane should be added to glare metrics.
