Working with the Bits and Digits of Lighting Studies in Architectural Education

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Keywords

Daylighting, design process, physical models, digital model

Abstract

The study investigates learning and pedagogical differences between using physical models and computational simulations for architectural lighting design studies. The vehicle of the study is a real life architectural project for a church building. The research reveals that users of physical models were more aware of the need for technical knowledge whilst the users of simulation software are more contended with the virtual results without evaluating them critically. Preliminary results not only confirm the long established view that the computational simulation lacks the tactile quality for architectural understanding; worst still, it gives inexperienced users illusions of knowledge and claims of understanding. To further validate the results, works involving a larger sample set and a more comprehensive design program should be conducted.

Introduction

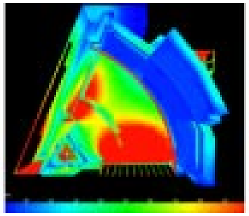
Daylight is a primary means of illumination for buildings. [1] Although artificial lighting is now widely used, people generally prefer natural lighting and views in their built environment. [2] [3] Recently, there has been a revival of interests in daylighting in the design of buildings. [4] Various methods are available for designers. [5] Photometric systems, model photometry and computational simulation techniques and their inter relationship for daylighting design have been developed and studied. [6] The main purposes of architectural models were to access subjectively and, since the days of illumination engineering, quantitatively the likely building qualities before the building was built. Many designers prefer model photometry. [7] The advantages of using architectural models have been well documented. [8] Nowadays, computational techniques are also available. [9]. Their accuracy and applicability have been largely validated. [10] [11] A number of studies have already been conducted. [12] [13] However, despite the advances made in computational lighting simulations, their use have not been wide spread. [14] A number of factors were hypothesized: they are not intuitive, they require skills beyond the traditional training of an architect, they are expensive and difficult to use, and, methods have not been developed to integrated them into the design process. [15]

Comparative studies between physical models and simulated models exist. [16] While previous studies mostly concentrated on scientific validation, the objective of this research is to examine, in details, the work process differences between using physical models and computational models in architectural lighting studies. The significance of this research is to understand the problem and to develop strategies to integrate scientific visualisation techniques into the design process. CAAD has been with us for a long time and numerous advancements have been made to aid the design decision-making process. Expectations are growing higher. Clients and designers will no longer be satisfied with a formal and visual approach to CAAD. It is the vision of this research to contribute in the field of design process, evaluative and performance study.

Methods and Experiments

To ensure inter-dependency and coordination, three teams were formed to process and monitor the research: physical model design team, computational model design team, and the research monitoring team. Using a day schedule method, the processes of the two design teams were recorded. Little cross references is needed between the two design teams, coordination is achieved largely through design briefings in the morning of the working day. As far as possible, the design teams were told to concentrate on design rather than process. The teams were required to keep a dairy of their works and to state more specifically the problems they encountered during their works. The research monitoring team made video recordings, observations and helped to collate the work process as the study progress. Based on past experiences, the contingencies of each of the two design teams had been identified. Work procedures were issued to both teams. [17]

The physical model team used a 2 x 2 x 1 mirror box artificial sky and a single cell photometer. Various grades of grey cards were used to construct the physical model. The reflectivities of the cards were measured using a luminance meter. Their reflectances were used by the computational modelling team. The computational modelling team used AutoCAD as their modelling tool. The files were imported into Lightscape for rendering. The team had prior experience with AutoCAD but not Lightscape. The team used 2 mid-end Wintel PC and 1 high end dual processor Wintel Graphics Workstation for their works. Two blocks of one working week were set aside for the two design teams. They worked side by side in the same Laboratory. The first working week was spent understanding the project, to learn the respective techniques required, and to build the models. They were asked to build their models to the design given by the architect and to make preliminary assessment of the lighting performances. Some cross calibrations were conducted between the two teams to ensure data consistency. The second working week was spent without any input from the architect. They were asked to develop options to improve

the original design. There was no need for the two teams to communicate with each other. At the end of the study, the two teams were interviewed. Their feedback were used to cross check against their diary and the research monitoring team's observations.

Results and Conclusions

In general, both teams were comfortable with the tools at hand. They were both confident that they could handle and complete the task in front of them. Contrary to previous reporting, it indicates that simulation tool, Lightscape in this case, has gone a long way towards user friendliness.

The physical modelling team reported difficulties in modelling real materials. They also questioned the viability of conducting tests under other sky conditions. The simulation team did not have the worries.

The study also shows that the feedback mechanism of the physical modelling process is instant, continues and intuitive, whereas that of the computational process is discrete and non-interactive. The simulation team felt that, compare to their counterparts, they were disadvantaged by the slow turn-around feedback loop. They also felt that while the physical modelling team could just move things around and notice the differences, they had to visualise their next step. And this does not inspire design option studies.

The research reveals that the research team favoured physical modelling for ease of use and computational simulation for flexibly. And that the users of physical models were more aware of the need for technical knowledge whilst the users of simulation software are more contended with the virtual results without evaluating them critically. The results confirm the long established view that the computational process lacks the tactile quality required for architectural understanding; [18]

The simulation team is more confident of their results than the physical modelling team. They seemed to believe that computational simulations were more accurate than measurements. This however is not necessary the case. The false sense of reliance, illusion of knowledge and claims of understanding among inexperienced users are most alarming to note.

In hindsight, both teams favoured physical models over simulated models – especially for the initial design stage. They appreciated the sketchy quality of physical models, their short learning curve, intuitiveness and visual feedback. However, they missed the 'technology' feel of the simulated models.

Future works

Due to limitations of time, the research captures only the feasibility stage of the design process. Moreover, the sample size of the study is limited and the results could not be regarded as conclusive. To further validate the results, works involving a larger sample set and a more comprehensive design program should be conducted.

References

1 P. G. Hopkinson, . Petherbridge, and J. Longmore, **Daylighting, The IES Code: Recommendations for good interior lighting**, Heinemann, IES, London, 407-408, 1966.
2 Ne'eman E, Light W, and Hopkinson R G, **Recommendations for the admission and control of sunlight in buildings**, Building and Environment, 11, 91-101, 1976.
3 Wineman J D, **Natural lighting in the office: the worker's perspective**. In Proceedings of the 18th Environmental Design Research Association Annual Conference, Environmental Design Research Association, Washington DC, 7-13, 1987.

4 Bryan H J, Feb, **Daylighting**, ASHRAE Journal, p26, 1990.
5 CIBSE, **Code for Interior Lighting**, 90, 1984.
6 Love J A, and Navvab M, **Daylighting Estimation under real skies: comparison of full scale photometry, model photometry and computer simulation**, Jnl of IESNA, Winter, 140-153, 1991.
7 Benton C., **Diminutive Design**, LD +A, 20(No.5):5, 1990.
8 Love J A, **Daylighting Estimation Under Real Skies Further Comparative Studies of Full Scale and Model Photometry**, Journal of the IES, 61-68, summer 1993.
9 Ng E, **Advanced Lighting Simulation in Architecture**, Virtual space, vol 1, pace publishing, Hong Kong, 1998.
10 Mahdavi A, Berberidou-Kallivoka L, Mathew P, Jen-Tu K , **Prediction of Daylight Factors in Realistic Settings: A demonstrative Case Study**, Jnl of IES, Winter, 40-44., 1993
11 Mardaljevic J, **Validation of lighting simulation program: a study using measured sky brightness distributions**, Amsterdam: 1997 Lux Europa 97 Proceedings, 555-569, 1997.
12 Ng E, Lam K P, Wu W, Nagakura T, **The application of computer simulation techniques to the design and preservation of a national monument**, IBPSA, Kyoto, vol 2, 555-562, 1999.
13 Ward G J,. **Application of Radiance to Architecture and Lighting Design**. In IESNA Conference Proceedings, 1995
14 Ng E, Lam K P, Wu W, Nagakura T, **Advanced lighting Visualisation in Architectural Design**, Research Report RP960019, National University of Singapore, Singapore, 1996.
15 Loe, D.L. and Rowlands, R.E., **The art and science of lighting" A strategy for lighting design**, Lighting Research and Technology 28(no.4) 162, 1996
16 Love J A, **Daylighting Estimation under real skies further comparative studies of full scale and model photometry**, Jnl of IESNA, 61-68, Summer 1993
17 Baker N, Fanchiotti A, and Steemers K, **Daylighting in Architecture: a European Reference Book**, James & James (Sinence Publishers) Ltd, London UK, 1993.
18 Moeck K M, , **On computer aided architectural lighting design: lighting design Techniques**, Journal of the IES, 33-41, Summer 1999

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