IDEA-l
— Bringing Natural Lighting to the Early Design Stages

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Abstract

This paper discusses the use of computers as design tools for natural lighting in the early stages of the architectural design process. It focuses on IDEA-l, a new natural-lighting design tool, currently under development, that is meant to offer the architect/designer a digital equivalent for scale models, artificial sky simulators and heliodons.

Introduction

Nobody will contest that light is of the utmost importance for architectural design. Its sole presence makes the perception of a built environment possible. Light determines a room's atmosphere and thus influences the mood of the people in it. A building's lighting design is critical to the function that building is meant to serve. Heat gains from sunlight can have a great impact on a building's energy balance. If light is so important, why doesn't the architect/designer have the proper software tools at his disposal to get a good estimate of the light's impact on his design?

This paper focuses on natural lighting as a design issue, on the tools that are available to the designer and on how natural lighting is treated during the design process. It consists of three parts, starting with a brief overview of the tools that are available to the architect in every-day practice. Next we discuss what can be improved, focusing on specifications for a new kind of computer tool. Finally the development of IDEA-l is treated, a new computer tool, which is an attempt to fulfil the specifications proposed in the second part.

Current Tools for Lighting Design

When looking at the tools that are available to the architect for examining natural lighting a clear distinction must be made between direct solar radiation (sunlight) and diffuse sky radiation (skylight)[1]. They have different energetic consequences, pose different kinds of problems and thus require different design tests.

Direct Solar Radiation

Traditionally sunshining and the control of insolation can be tested manually and graphically by means of a few different kinds of projections on

sunpath diagrams. Since this can fairly easily be implemented in a computer programme, an increasing number of CAD-packages offer simple solar tests. With them sunpath diagrams, shadowing and solar envelope can be determined. All in all we can conclude that there is no shortage of tools (digital or other (to check direct solar radiation.

Diffuse Sky Radiation

The history of "skylight" tests shows a rather more complex picture.

For decades the only tools that the architect/designer had at his disposal to check the impact of daylight on his designs consisted of diagrams, protractors and tables, which gave him an estimated value for the daylight factor in a given location [2] and, of course, the scale model in the artificial sky.

However, in these last few years of the "post-fluorescent" era attention has turned to the use of natural lighting. Together with a growing interest in global environmental issues and new insights in the psychological and physiological effects of daylight deprivation, the availability of increasingly powerful computer technologies has triggered new research on how daylighting can be integrated in an architectural design while designing and consequently the development of new software tools.

First to be developed were a small number of integrated energy simulation packages, which provided a means of evaluating the energy balance of a building. The best-known examples include ADELINE [6], ESP-r [3] and DOE [5].

Current Design Practice

The traditional tools have never really become an intrinsic part of the design process. Many manual methods on one hand prove to be rather cumbersome to use and produce an output (e.g. the daylight factor (that does not really give one much practical information. Testing scale models under artificial skies on the other hand can become very costly and time consuming.

The availability of software tools might lead one to believe that they be widespread in architectural practice. However, given their highly specialised nature, their use is limited to lighting design firms and consultants. This means that lighting design becomes the privilege of a minority of prestigious projects, and that it remains restricted to the final stages of the overall design process. Yet, it seems more than plausible that the quality of lighting can only benefit from the integration of lighting design in all stages of every-day practice. All too often early design choices are uninformed ones, which the designer spends his time optimising.

Towards a New Tool

As early design decisions tend to have the biggest impact, the designer can only benefit from the development of new easy-to-use tools that can assist him right from the start.

Several research projects have recognised this and have focused on the development of design tests that can be deployed in the earlier stages of the design process, so that daylighting can become more of a design issue, rather than a consequence that can only be affected by the addition of sophisticated lighting control equipment. Among the most advanced and promising examples we find LBL's Building Design Advisor [1] and EPFL's LESO-DIAL [7].

What should such a new tool look like? We can summarise all specifications in two principal requirements: practicality and low threshold. Our target group consists of architects in general, i.e. people with feeling for the problem of manipulating light, but without any special technical expertise in that field, and, perhaps more importantly, a community that has taught itself to rely on its intuition. If we ever hope to introduce a new element in an already labour-intensive process, we should make sure its benefits are obvious and the extra effort is

minimal. If the tool does not provide a sufficient amount of useful information with a minimum of hassle, architects simply will not use it [4].

Functionality

What we need is a cost-efficient and practical design tool that proves useful at the beginning of the design process. At this stage, the architect is hardly ever dealing with artificial lighting, but instead he's merely exploring his options, composing light and spaces, volumes, functional organisations, building elements, walls, windows. If we want to provide a lighting design tool for this stage, it should be focused on natural lighting, i.e. the influence of skylight and sunlight. The tool should provide a digital alternative for existing tools (the scale model in the artificial sky and the heliodon (, hand calculation methods (the lumen method, the daylight factor method and the flux transfer method (and graphical techniques (protractors, dot charts, and diagrammatic methods. In addition, the tool can offer the user a semi-realistic rendering, as a means of evaluating the aesthetic merits of his design.

Dealing with Raw Data

Typical of any design process is the absence of detailed data in the early stages: the architect cannot be bothered with reflection factors, colour spectra or sky distribution functions. He's still working on the geometry, and his material choices are far from precise. Moreover, this is exactly the kind of data that belongs in the realm of the lighting expert. This should be taken into account when developing the tool. Data input should be intuitive rather than numerical: numeric values should be hidden from the user and be replaced with verbal descriptions. For instance, when assigning reflection factors the user should get a range of choice going from "very dark" to "very light", which the application can then translate to appropriate numeric values (see figure).

Full Interactivity

For our programme to be a design tool, it needs to be fully interactive. This means that the user should be able to go swiftly back and forth between his CAD package and the new tool. Ideally both pro-

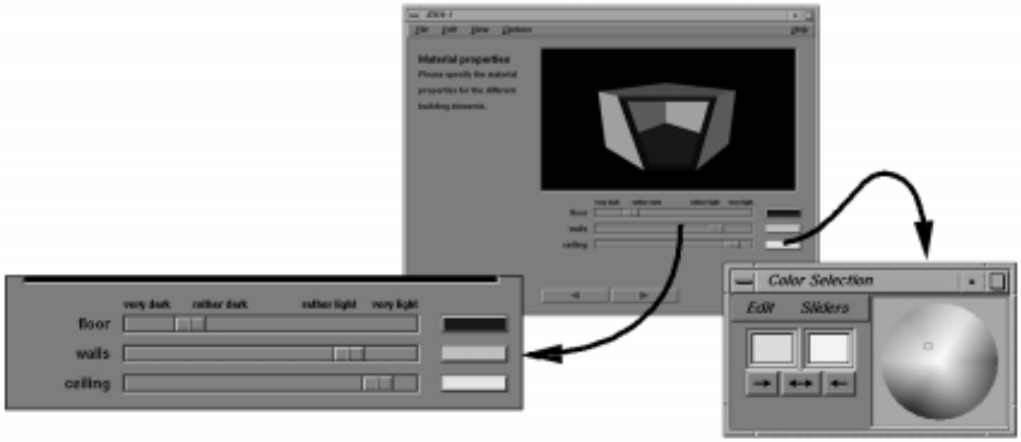

Figure 1:
An example of the user interface.

grammes should use one and the same digital model, so that every change made in one is reflected in the other. Alternatively, both programmes can be made to communicate so that both digital models can be checked for inconsistencies.

IDEA-I

This programme, currently under development at K.U.Leuven, is an attempt to fill the void in the designer's tool chest according to the specifications listed above. It is part of the larger IDEA+ project, which aims to provide a new **I**ntegrated **D**esign **E**nvironment for **A**rchitects. A first prototype, which will run on IRIX, is expected in the summer of 2000.

Conclusion

We have presented specifications for a new lighting design tool offering a quick estimate of the impact of design choices on the aesthetic, energetic and functional quality of architectural projects. With it, architects will be able to get a grip on everyday daylighting problems for which, until today, they have had to rely on their intuition. Though we have a long way to go before we attain a truly integrated design environment, we feel confident that this is a first step in the right direction.

Notes

1 We use the terminology as proposed by CEC

References

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