DESKTOP RADIANCE
A NEW TOOL FOR COMPUTER-AIDED DAYLIGHTING DESIGN

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Introduction

The use of daylight for the illumination of building interiors has the potential to enhance the quality of the environment while providing opportunities to save energy by replacing or supplementing electric lighting. Moreover, it has the potential to reduce heating and cooling loads, which offer additional energy saving opportunities, as well as reductions in HVAC equipment sizing and cost. All of these benefits, however, assume proper use of daylighting strategies and technologies, whose performance depends on the context of their application. On the other hand, improper use can have significant negative effects on both comfort and energy requirements, such as increased glare and cooling loads. To ensure proper use, designers need tools that model the dynamic nature of daylight and accurately predict performance with respect to a multitude of performance criteria, extending beyond comfort and energy to include aesthetics, cost, security, safety, etc.

Research and development efforts during the last twenty-five years have resulted in a number of computer-based daylighting tools, with varying degrees of modeling capabilities and prediction accuracy. Some of them, such as SuperLite [Modest 1982] and Lumen Micro [Baty 1996], are limited to daylighting computations with strict bounds on their modeling capabilities, while others, such as Radiance [Ward & Shakespeare 1998] and Lightscape [Khodulev and Kopylov 1996], can model environments of arbitrary complexity and extend beyond daylighting and lighting computations to generating rendered images that are most helpful for the evaluation of lighting quality and aesthetics. Radiance is the most accurate tool for predicting daylighting performance, mainly because its calculations are based on true energy balance equations.

The development of Radiance began in 1988 in an effort to accurately predict the distribution of light in architectural spaces, and it has been continuously refined, enhanced and validated since then. Radiance uses a combination of ray tracing and radiosity algorithms to determine luminance or illuminance values, which are then further processed to produce photometrically accurate renderings. Radiance was developed as a collection of many interrelated UNIX processes, capitalizing on the capabilities of the UNIX operating system. All Radiance functionality is accessed through sequences of UNIX commands, while the description of the scene to be rendered is expected in the form of a file that contains special keywords and alphanumeric entries that describe the geometry of surfaces along with the optical properties of materials and light sources. This type of input requires significant time investment in learning the required keywords and syntax. Moreover, even experienced Radiance users need significant time to describe a building or a space in terms of keywords and xyz coordinates. As a result, Radiance is mostly used on large architectural projects that can support the associated expenses.

Desktop Radiance is being developed to make the Radiance simulation engine easy to use on Desktop computers used by the majority of building designers. The strategy to achieving this goal is based on porting the Radiance engine from UNIX to Windows and developing an AutoCad-based front end (Figure 1) along with libraries of materials, glazings, electric lighting luminaires and furniture. These libraries are accessible through a graphical user interface (Figure 2) and include an editor for user-defined materials. The overall package includes a simulation control interface (Figure 3) an interactive rendering module that allows quick view and control of the rendered image while it is being computed (Figure 4). Moreover it includes an application that allows viewing of Radiance images and their further manipulation with respect to changing exposure, generating isolux and false color images, as well as adjusting the image to account for the sensitivity and dynamic range of the human eye (Figure 5). Finally, Desktop Radiance includes a Simulation Manager that allows management and control of multiple simulation runs (Figure 6). Through the Simulation Manager, users can duplicate and modify prior simulations to explore alternative scenarios with respect to accuracy, time of the day, sky conditions, etc.

Desktop Radiance 1.0 is available free of charge from http://radsite.lbl.gov/deskrad. The current development efforts focus on the development of editors for user-defined materials, glazings, luminaires and furniture, the specification of user-defined sky luminance distributions, and the exploration of the development of links to additional CAD software.

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Figure 1. AutoCad R-14 is used as a front end to the Desktop Radiance modules. All of the functionality of Desktop Radiance is available through an AutoCad menu.

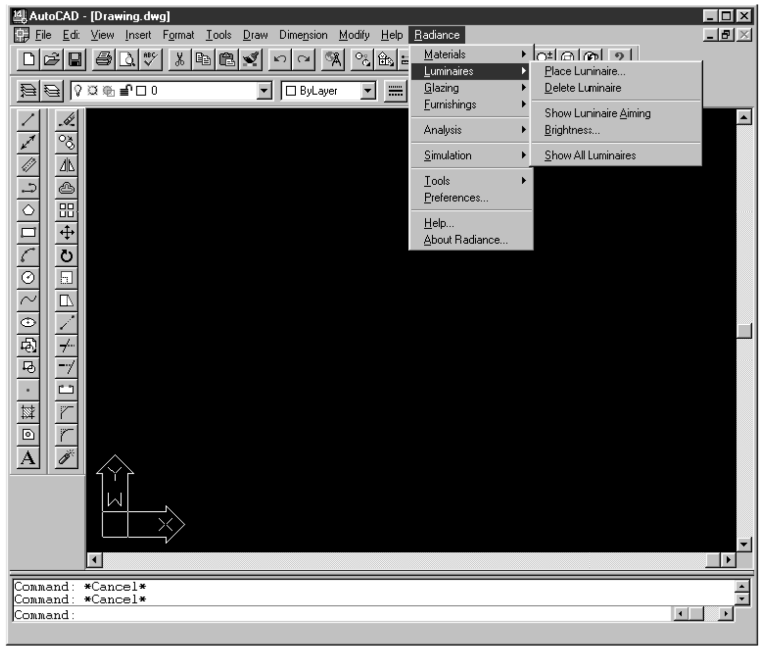
Figure 2. Desktop Radiance users can select materials, glazings, luminaires and furniture from corresponding libraries, through a graphical user interface.

Figure 3. All simulation control options in Desktop Radiance are set through a graphical user interface.

Figure 4. Desktop Radiance includes a module that allows users to review rendered images while they are being generated, giving them an opportunity to change simulation parameters to better fit their needs.

Figure 5. Desktop Radiance includes a module that allows users to view precomputed Radiance images and display them with superimposed iso-illumination curves or in false color that indicates light levels.

Figure 6. The Simulation Manager allows users to management and control multiple simulation runs quickly and easily. Users can modify and rerun simulations for any number of different scenarios.



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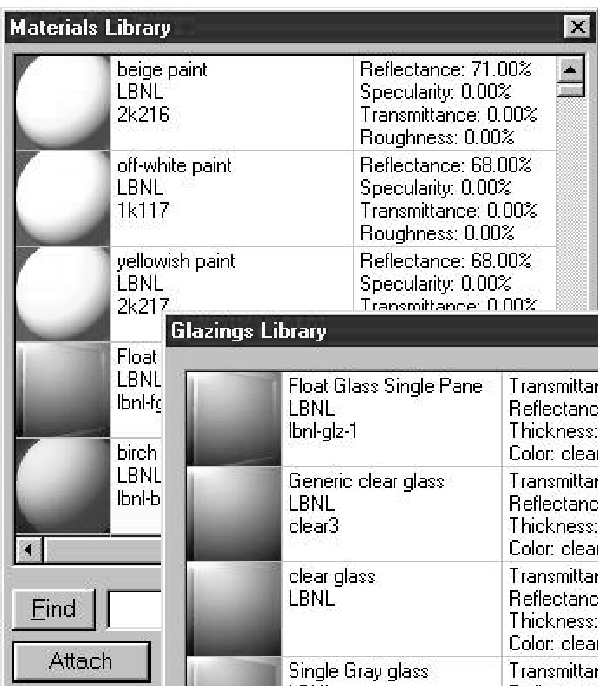

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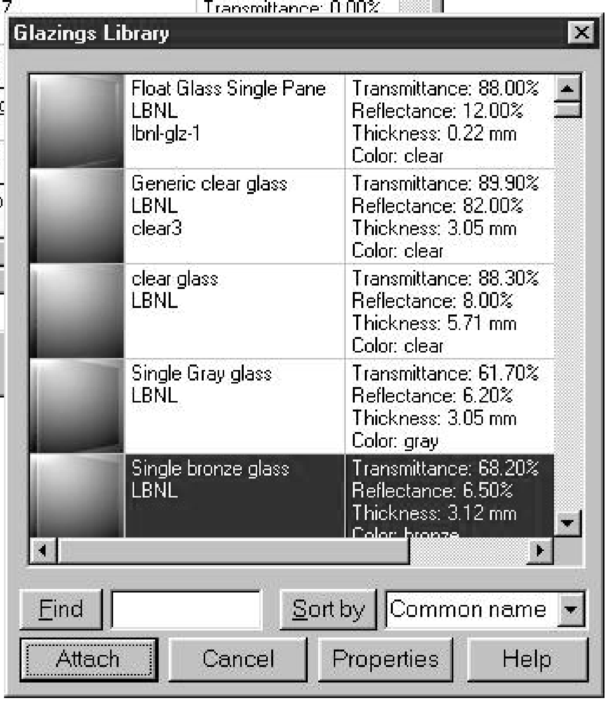

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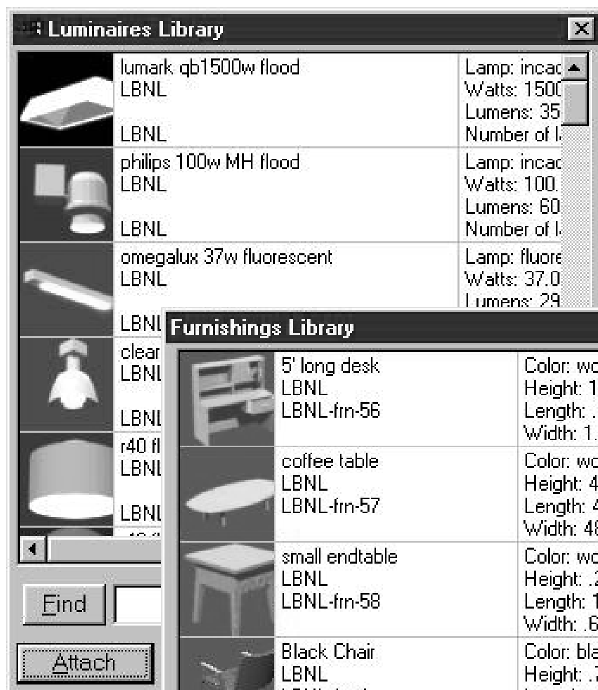

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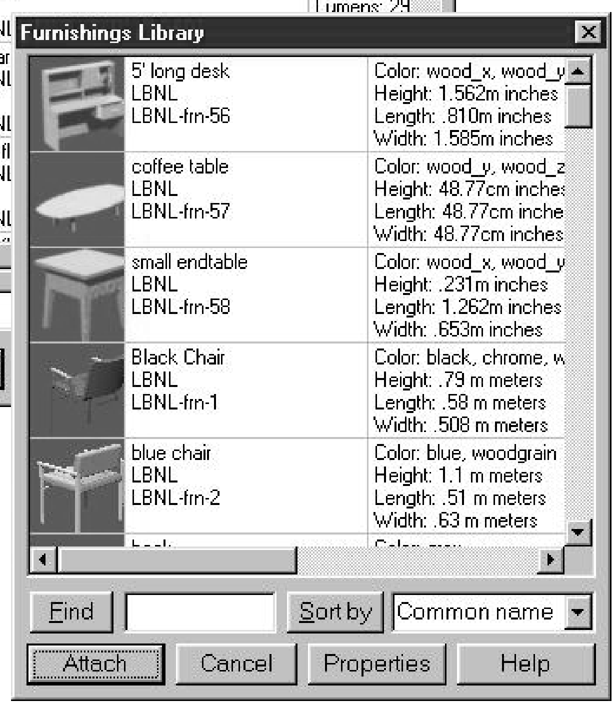

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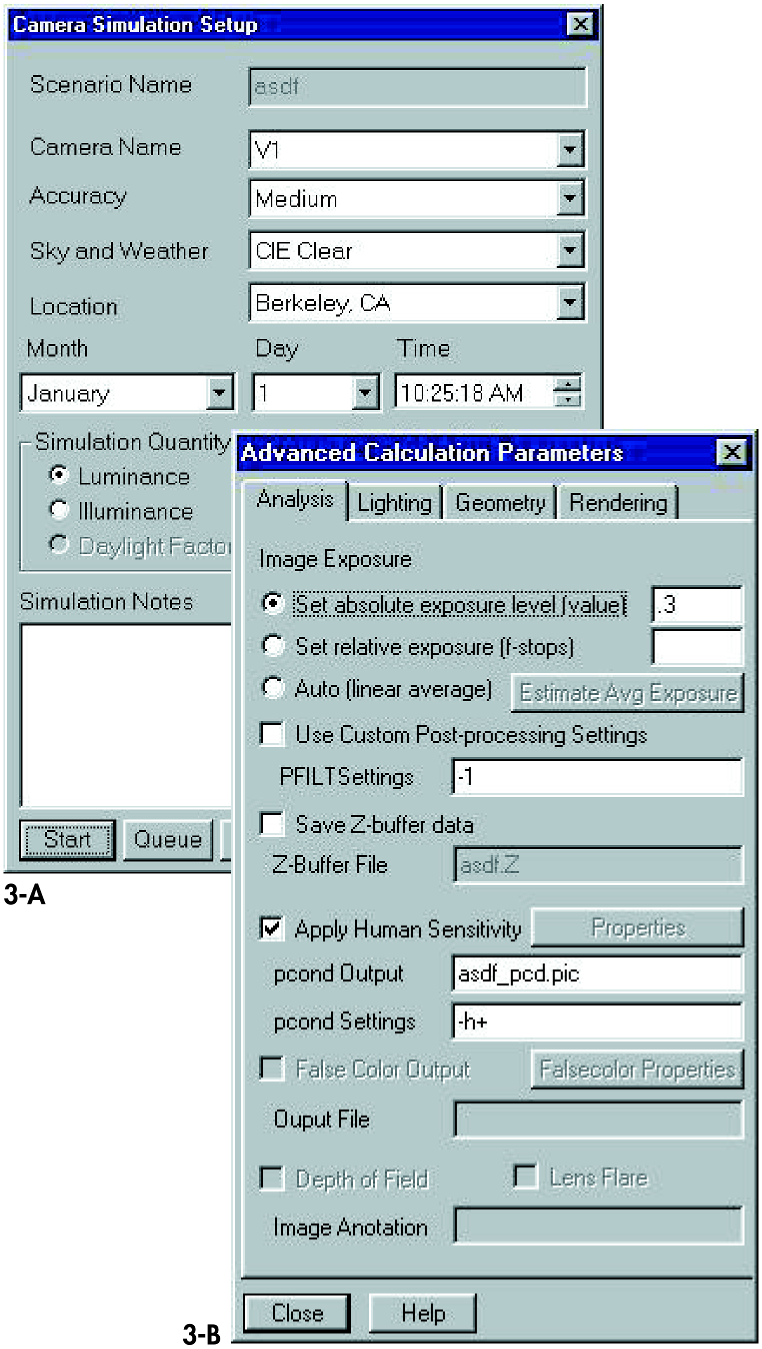

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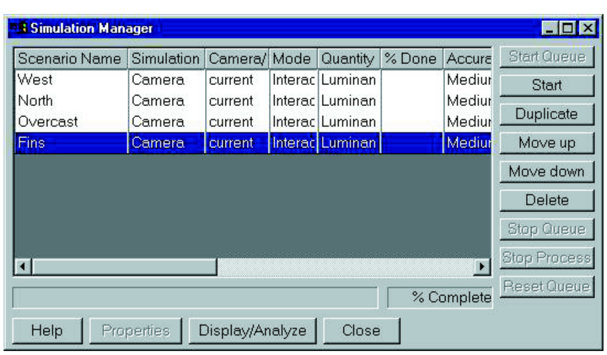
3-B



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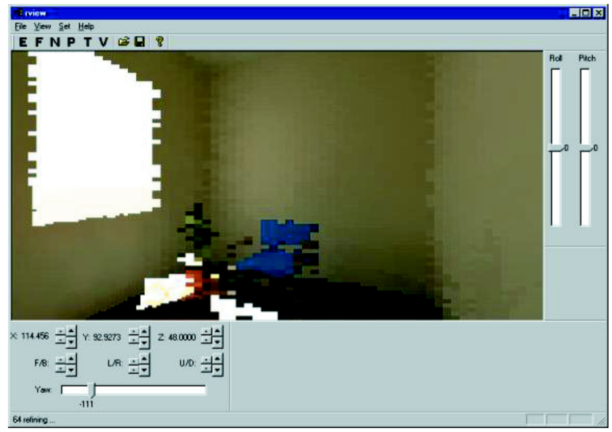

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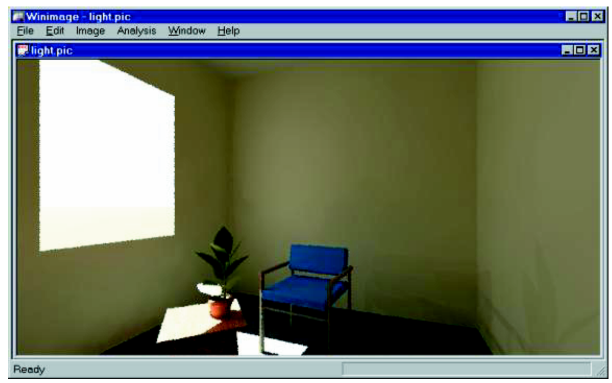

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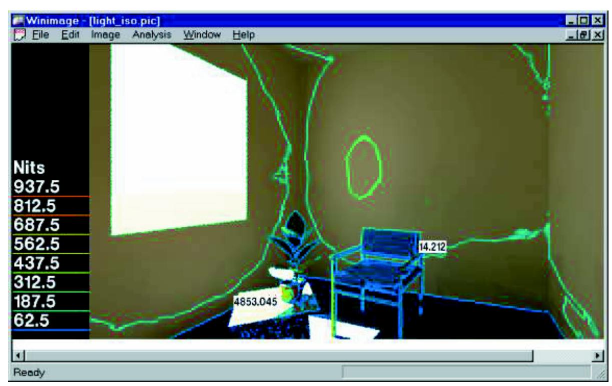

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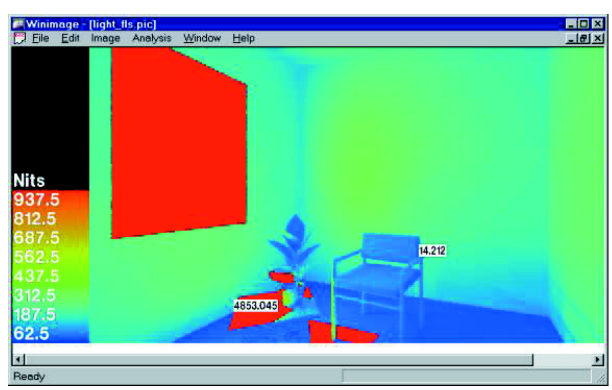

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