Lighting/Daylighting Software

Current State of the Art Report

A Report for GPIC Task 2.2

by

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Overview

This report summarizes the findings from a review of a wide range of lighting software tools with a focus on the modeling capabilities of these programs, and in particular the capabilities of these programs in the area of daylighting analysis. Some of these tools are limited in the types of lighting systems, daylight delivery systems or sky models they can assess, or in the complexity of the building or space models they can consider, not only related to interior space geometry and the daylighting systems, but also the exterior and surround conditions that can affect the view of the sky or daylight that is reflected to building apertures. The analysis metrics available and the ability of the software to address annual daylighting and energy consumption were also considered, including the application of shading devices, electric lighting systems, and integrated electric lighting control.

At present, most of these tools are configured to model single spaces rather a variety of areas across an entire building. The link between BIM or CAD modeling software and these lighting analysis tools is often lacking or of limited usefulness, requiring model rework or complete model development to produce an appropriate space description for the software. One electric lighting analysis software tool (ElumTools) is currently designed to operate within Revit.

A number of the tools that were reviewed are available for free via the Internet, and some of these provide capabilities that are unique to that program. This work focused primarily on software tools that are being applied within the United States, but does consider a few programs from European vendors.

Nearly all of these tools were studied by installing and running the program on an actual computer. The software manual and other literature of a technical nature were used to gather additional information. Pages 3 and 4 contain a list of the different program features that were assessed for each of these tools, along with a short description of each of these software attributes.

The lighting software programs that were reviewed and which are contained in this report are listed below, along with the page numbers where information on these programs appears in this report.

TABLE 1. Index of Lighting Software Tools Reviewed

Software Capabilities – Item Descriptions

Cost:

This section notes the cost of the software program as either paid or free.

Weather Data:

This section contains all weather related capabilities.

Weather File:

This section notes whether the program accepts TMY data or other such weather files.

Sky Type:

This section lists the sky types used by the program.

Daylighting Method:

This section contains all daylighting method related capabilities.

Sidelighting:

This section describes the potential of the program to complete sidelighting calculations.

Skylighting:

This section describes the potential of the program to complete skylighting calculations.

Geometry and Materials:

This section contains all geometry and material related capabilities.

Geometry:

This section describes the type of geometry allowed by the program, whether that is user imported or simple creation within the program. This section also notes whether the geometry can be modified from within the program.

Complex Facades:

This section describes how complex the wall geometry can be. This is typically only important if the program doesn't allow user imported geometry.

Materials and Glazing types:

This section notes how the program handles reflectances and transparent for diffuse glazing.

Exterior Modeling:

This section describes whether exterior modeling is taken into consideration within the program.

Electric Lighting:

This section contains all electric lighting capabilities.

Luminaire Information:

This section contains information on the type of luminaire definitions available. This includes built in luminaires or the ability to import an .ies file.

Control Strategies:

This section contains information on the program's ability to control zones by multiple methods.

Control Zones:

This section contains information on the program's ability to control different zones separately.

Photosensor:

This section contains information on the incorporation of photosensor control into the program.

Occupancy Schedules:

This section describes the ability to incorporate an occupancy schedule into the program.

Shading Devices:

This section describes the programs capabilities with respect to shading devices.

Shade Type:

This section describes what types of shades are able to be used (blinds, shades, variable transmittance) and if they incorporate specular components or only diffuse.

Control Strategies:

This section contains information on the program's ability to control zones by multiple methods.

Control Zones:

This section contains information on the program's ability to control different zones separately.

Simulation Parameters:

This section describes the ability to affect the level of detail for the simulation parameters.

Output:

This section describes the various output types from the programs.

Metrics:

This section describes the various lighting and energy metrics the program can provide (DF, DA, Illuminance, kWh, etc.).

Renderings:

This section describes the level of renderings available from the program.

AGI32

Cost:

$895

Weather Data:

Weather File:

TMY weather data is not addressed.

Sky Type:

The following sky types can be selected for analysis: IES clear, partly cloudy, and overcast, plus CIE General Sky Types 1 through 15.

Daylighting Method:

Sidelighting:

AGI32 allows for the simulation of sidelighting.

Skylighting:

AGI32 allows for the simulation of skylighting.

Geometry and Materials:

Geometry:

Geometry may be imported from DWG or DXF, or can be constructed within AGI32. There are no limitations on room configuration or shape.

Complex Facades:

Complex facades are possible due to the ability to import arbitrary geometry for surface elements.

Materials and Glazing types:

Reflecting surfaces are diffuse for lighting calculation purposes, but specular contributions can be considered for renderings.

Glazing surface can be either transparent (image preserving) or perfectly diffuse.

Exterior Modeling:

Exterior surfaces must be called out with a checkbox. This is because windows are treated using candela distributions that are derived from skies as well as reflected light from the ground and other exterior surfaces. Exterior objects can be modeled using basic polygonal elements.

Electric Lighting:

Luminaire Information:

AGI32 has the ability to import IES photometry files.

Control Strategies:

AGI32 does not address photosensor control in response to available daylight levels.

Control Zones:

N/A

Photosensor:

N/A

Occupancy Schedules:

N/A

Shading Devices:

Shade Type:

The program allows for any geometry to be used. Shade materials available are opaque and perfectly diffuse.

Control Strategies:

Shades can be considered only as part of a standard room model. No control strategies are therefore applied.

Window Control Groups:

N/A

Simulation Parameters:

Mesh size can be addressed globally or locally (one surface at a time). Sizes of patches (flux sending areas) and elements (flux receiving areas) can be established by the user for reflecting surfaces, as can the size of window and luminaire elements. Adaptive subdivision can also be applied to subdivide elements based on changing luminance distributions. Simulation stopping criteria can also be modified based on the percentage of flux remaining.

Windows are modeled using a photometric distribution that has been computed based on light arriving from all exterior sources and exterior reflecting surfaces.

Output:

Metrics:

Metrics considered include illuminance, exitance, luminance and daylight factor, as well as and Unified Glare Rating (UGR). Daylight glare calculations are not permitted.

No Annual daylight metrics can be computed.

Illuminance contours can be viewed for any hour of the year. Daylight studies permit the analysis of daylighting across specified time increments (month, day, or hour).

Renderings:

Renderings can be visual or pseudocolor. Daylight studies can be performed that include a timed sequence of renderings across or day or any desired time period.

Reference:

www.agi32.com

COMFEN

Cost:

Free.

Weather Data:

Weather File:

Weather data for a selection of cities across the world, and for a large number of California sites are available for use with the program.

Sky Type:

Individual sky types are not available.

Daylighting Method:

Sidelighting:

Fenestrations are permitted on a single exposure of a building. Multiple apertures are allowed of different sizes and types.

Skylighting:

Not available.

Geometry and Materials:

Geometry:

Only a rectangular space with a flat ceiling is permitted.

Complex Facades:

N/A

Materials and Glazing types:

Wall types are able to be selected, but no modification of reflectance for interior surfaces is permitted. The glazing library has many products from which to select. User defined window systems can also be created within the program.

Exterior Modeling:

No exterior obstructions can be considered.

Electric Lighting:

Luminaire Information:

Only w/ft^2 are required.

Control Strategies:

The type of control permitted in COMFEN is either multi-level switching or continuous dimming.

Control Zones:

Two zones are permitted within COMFEN. The depth of the primary control zone is dependent upon either the total depth, height of the room, or 15 feet, whichever is the minimum. The depth of the secondary control zone is the remainder of the room depth which is not covered by the primary control zone.

Photosensor:

A photosensor is automatically placed at a distance from the window wall of 2/3 the depth of the control zone. It is centered on the length of the window wall. The photosensor is placed 2.5 feet off of the floor.

Occupancy Schedules:

No occupancy schedule is able to be entered into the program.

Shading Devices:

Shading devices are available for use in COMFEN, with the controls based on the EnergyPlus simulation engine. This engine is used to calculate results. Exterior non-dynamic shades are also permitted in this program.

Shade Type:

Shades permitted in EnergyPlus are permitted in COMFEN

Control Strategies:

Three control strategies are permitted in COMFEN based on daylighting: Always On, Always Off, and solar radiation dependent. The solar radiation is a user entered threshold value for the total w/m^2 of direct and diffuse solar radiation incident on the window. Other methods of control are permitted based on thermal thresholds.

Control Zones:

N/A

Simulation Parameters:

This program utilizes the EnergyPlus simulation engine. No parameter settings can be modified.

Output:

Metrics:

Annual energy savings (heating, cooling, lighting) as well as average illuminance data for each month are presented. These results are shown in a variety of graphs and are compared against other model scenarios for each metric. Illuminance values are able to be calculated for individual hours, but are not considered for the energy calculation.

Renderings:

N/A

Daysim

Cost:

Free

Weather Data:

Weather File:

Daysim makes use of climate data to select the appropriate sky type.

Sky Type:

Perez Skies based on TMY weather data. It can also convert hourly weather data for finer increments with sky variations.

Daylighting Method:

Sidelighting:

Daysim allows for the simulation of sidelighting.

Skylighting:

Daysim allows for the simulation of skylighting.

Geometry and Materials:

Geometry:

Standard Daysim takes input from Radiance .rad files and .3DS files. A Rhino plug-in is also available.

Complex Facades:

Complex facades are possible due to the ability to import arbitrary geometry for surface elements.

Materials and Glazing types:

All standard Radiance materials can be used within Daysim.

Exterior Modeling:

Daysim can consider exterior obstructions when simulating daylight conditions.

Electric Lighting:

Luminaire Information:

Daysim has the ability to import IES photometry files in the advanced version (V3.0), which is currently available in beta format through Penn State.

Control Strategies:

Daysim allows the use of either on/off or continuous dimming of the control zone. Dimming can be applied with or without system shutoff beyond the point where minimum ballast output is reached.

Control Zones:

Daysim can have only a single lighting zone that is controlled in response to daylight. A second non-dimmed zone is also permitted.

Photosensor:

Daysim uses photosensor directional sensitivity input files and calibrated photosensor control algorithms to control the electric lighting within the controlled zone. This is done by calibrating the system under a selected daylight condition with respect a critical work plane analysis point.

Available control algorithms include open and closed-loop proportional control, closed-loop constant setpoint control, and both open and closed-loop switching.

Occupancy Schedules:

An occupancy schedule can be applied within Daysim.

Shading Devices:

Shade Type:

The program allows for any geometry to be used.

Control Strategies:

Automatic control can be done by a photosensor, by profile angle, or by a combination of the two.

Window Control Groups:

Two window groups can be controlled separately with three different shade settings per group.

Simulation Parameters:

All Radiance based parameters can be adjusted to affect simulation time. Bounces can be increased to improve precision or decreased to improve calculation time.

Output:

Metrics:

Daysim calculates illuminances for all work plane points for all hours of the year. Daylight factor, daylight autonomy, continuous daylight autonomy, spatial daylight autonomy, useful daylight illuminance, and threshold illuminance can be evaluated using the program. Daysim also determines energy savings based on the calibrated control algorithm for the electric lighting system.

Illuminance contours can also be viewed for any hour of the year for the sky condition that has been selected based on the weather tape conditions.

Renderings:

Renderings can be produced with the Daysim. (??)

Reference:

www.daysim.com

Ecotect

Cost:

See Manufacturer for pricing – not published.

Weather Data:

Weather File:

Ecotect makes use of climate data to select the appropriate sky type.

Sky Type:

(1) CIE Overcast Sky Condition
(2) CIE Uniform Sky Condition

Daylighting Method:

Sidelighting:

Ecotect allows for the simulation of sidelighting.

Skylighting:

Ecotect allows for the simulation of skylighting.

Geometry and Materials:

Geometry:

Ecotect allows for the creation of complex geometry within the program. Many types of geometry files can be imported into the program.

Complex Facades:

Complex facades are possible due to the ability to import geometry and create geometry within the program.

Materials and Glazing types:

Surface reflectances can be selected within the program for individual surfaces or surface types. Glazing transmittance can be selected in a similar manner to the surface reflectances. When importing certain models, the program attempts to determine what the surface is and select the appropriate material type.

Exterior Modeling:

Ecotect can consider exterior conditions and obstructions when simulating daylight conditions.

Electric Lighting:

Luminaire Information:

Ecotect has the ability to import ies photometry files.

Control Strategies:

Ecotect allows the use of either on/off or dimming of the control zone. This is determined by a daylight factor analysis.

Control Zones:

Electric lighting can be separated into multiple zones.

Photosensor:

Ecotect is not capable of employing photosensor control in the daylighting simulations.

Occupancy Schedules:

An occupancy schedule can be created within Ecotect.

Shading Devices:

Shade Type:

The program allows for any geometry to be used.

Control Strategies:

There is no automatic control of shading devices.

Control Zones:

N/A.

Simulation Parameters:

The program has a few settings for precision, ranging from low to high. For the Radiance components, the program permits the user to adjust all Radiance parameters, including the number of bounces.

Output:

Metrics:

Ecotect has the ability to calculate lighting levels based on certain sky types using its own analysis modules. Ecotect can also produce daylight factor information for any point on an analysis grid. With the capability to export models to Daysim, the program also has the potential to apply all of Daysim's capabilities and import any illuminance files back into Ecotect for display purposes.

Renderings:

Renderings can be completed with the use of Radiance. In addition, the program has many useful images, such as sun paths and shadow diagrams that can inform the building design process.

Reference:

www.autodesk.com/ecotect-analysis

ElumTools

Cost: **$549**

Weather Data:

Weather File:

N/A

Sky Type:

N/A

Daylighting Method:

Sidelighting:

N/A

Skylighting:

N/A

Geometry and Materials:

Geometry:

Geometry is taken from the data incorporated in Revit. The user can select from different levels of detail to include in the analysis model.

Complex Facades:

N/A – No daylight calculations are currently possible.

Materials and Glazing types:

Material properties (color, reflectance, etc.) that are applied to the electric lighting system analysis are taken from the data entered to Revit.

Exterior Modeling:

N/A

Electric Lighting:

Luminaire Information:

ElumTools applies IES photometry files. These are linked to the luminaire descriptions in the luminaire

Control Strategies:

Control Zones:

Photosensor:

N/A

Occupancy Schedules:

N/A

Shading Devices:

Shade Type:

N/A

Control Strategies:

N/A

Window Control Groups:

N/A

Simulation Parameters:

Mesh size is addressed by modifications to the material. Adaptive subdivision subdivides elements based on changing luminance distributions.

The program currently is capable of only modeling the electric lighting within a space. No daylight calculations can be performed.

Output:

Metrics:

Metrics that can be calculated include only illuminance at the present time.

Renderings:

Renderings are available within Revit in an interactive viewer.

Reference:

http://www.elumtools.com

ENERGY PLUS

Cost:

Free.

Weather Data:

Weather File:

Weather data for a selection of cities across the world are available for use with the program.

Sky Type:

Individual sky types are not available.

Daylighting Method:

Sidelighting:

Multiple apertures are permitted of different size, type, and orientation.

Skylighting:

Permitted, although the analysis of deep and complex wells and surface geometry is likely to be inaccurate for the reflected light contribution to a space.

Geometry and Materials:

Geometry:

Detailed geometry is permitted, except that the full effects of complex fenestration conditions such as light shelves are not accurately modeled for the reflected light contribution.

Complex Facades:

Limited. Energy Plus direct daylight calculations consider the direct flux incident on a window and apply daylight factors to the direct illuminance at the interior analysis points.

Materials and Glazing types:

Spectral glazing transmittance data is permitted. Material reflectances can be specified.

Exterior Modeling:

Exterior obstructions such as adjacent buildings, overhangs and fins can be considered.

Electric Lighting:

Luminaire Information:

Only w/ft^2 are entered. Luminaire photometric performance is not considered.

Control Strategies:

A variety of control strategies are permitted, including multi-level switching and continuous dimming to either a minimum level or to a minimum level with shutoff.

Control Zones:

Lighting control is established by the user through a linkage with an illuminance analysis point and the specification of the lighting power associated with that control zone. Two daylight control zones are permitted within each thermal zone.

Photosensor:

N/A (control is based on a work plane illuminance point).

Occupancy Schedules:

Detailed occupancy schedules can be entered into the program.

Shading Devices:

Shading devices are modeled as a simple diffusing layer at the glazing surface . Exterior non-dynamic shades are permitted.

Shade Type:

Both electrochromic glazing and perfectly diffuse shading can be modeled.

Control Strategies:

Shading device activation can be based on incident radiation or glare calculations. The settings for electrochromic glazing can be based on interior illuminance calculations with the transmittance set to maintain the target point at a prescribed illuminance value.

Control Zones:

Shading control zones are possible, but to a limited degree. For glare control, shades are closed in the order of entry until glare limits are met.

Simulation Parameters:

Parameter settings for the lighting calculations cannot be modified. No electric lighting calculations are performed. Daylighting calculations consist of daylight factors for direct light with a split flux method applied to determine the reflected light contribution. The reflected contribution is therefore uniform across the space.

The Open Studio version of Energy Plus will have links to Radiance daylighting calculations.

Output:

Metrics:

Lighting energy savings, and illuminance at the simulations points can be obtained on an hourly basis. In addition, daylight glare index can be computed, and can be apply to control shading devices. Most data is in a simple numerical format

Renderings:

N/A in the standard version of Energy Plus. The Open Studio system that links to Energy Plus will have rendering capability.

IES-VE

Cost:

See Manufacturer for pricing – not published.

Weather Data:

Weather File:

IES-VE makes use of climate data to construct a sky for a specific weather condition based on a suitable fraction of a standard clear and overcast sky.

Sky Type:

(1) CIE Overcast: Normalized overcast sky, representing a standard cloudy day
(2) Circumsolar: Normalized direct-beam solar radiation per sun position only
(3) Diffuse: Normalized solar radiation for a clear sky omitting the direct-beam component

Daylighting Method:

Sidelighting:

IES-VE allows for the computation of sidelighting applications.

Skylighting:

IES-VE allows for the computation of skylighting applications

Geometry and Materials:

Geometry:

IES-VE imports complex geometry from many file types. There also permits users to modify geometry within the program.

Complex Facades:

The ability to import geometry allows for any wall construction to be simulated.

Materials and Glazing types:

Materials and Glazing types can be applied within the program. When using the Radiance portion of the program, there is a Radiance material database.

Exterior Modeling:

Exterior models can be incorporated into the simulation, this includes other buildings or overhangs.

Electric Lighting:

Luminaire Information:

IES-VE imports ies files for the calculation of electric light levels.

Control Strategies:

IES-VE uses sensor points to control the electric lighting based on work plane illuminance. The program can use continuous dimming or step dimming.

Control Zones:

IES-VE allows for at least one lighting control zone.

Photosensor:

IES-VE uses sensor points for the lighting control. This does not take into consideration control algorithms with calibration.

Occupancy Schedules:

Occupancy schedules can be created from within IES-VE.

Shading Devices:

Shade Type:

With its application of Radiance, a wide variety of shading types are possible.

Control Strategies:

Sensor points are used to determine whether the shades should be employed or not.

Control Zones:

Control zones are based on the power density within a particular control zone. Performance of a control zone is based on the calculated daylight at a control zone's sensor.

Simulation Parameters:

When applying Radiance, the simulation parameters can be adjusted. Quick simulations can be completed to determine if everything is working correctly. Longer simulations with more bounces can be completed to improve the accuracy of the model.

Output:

Metrics:

This program can calculate the total illuminance on all surfaces within the room as well as the average daylight factor for each of those surfaces. IES-VE also calculates electric lighting savings based on the sensor point in the room and which electric light control strategy is selected.

Renderings:

Renderings can be produced within IES-VE using the Radiance software.

Reference:

http://www.iesve.com

Radiance

Cost:

Free

Weather Data:

Weather File:

A wide variety of skies can be input, including customized distributions.

Sky Type:

CIE Clear (with or without sun), CIE Overcast, CIE Intermediate Sky, and Uniform sky. Skies can also be based on zenith luminance, solar irradiance, turbidity. Perez skies are generated using *gendaylit.exe.*

Daylighting Method:

Sidelighting:

Radiance allows for the simulation of sidelighting.

Skylighting:

Radiance allows for the simulation of skylighting.

Geometry and Materials:

Geometry:

Geometry may be transformed to a RAD (.rad) file from DXF using the *dxf2rad.exe* program available from http://www.schorsch.com/en/download/dxf2rad/.

Geometry can be converted from Wavefront .obj files to .rad using *obj2rad.exe*.

Complex Facades:

Complex facades are possible due to the ability to import arbitrary geometry for surface elements.

Radiance also permits BSDF distributions to be applied for the analysis of complex facades (blinds, etc.) in mkillum rtcontrib.

Materials and Glazing types:

Radiance permits a wide variety of materials, from perfectly diffuse or clear to plastic, metal, glass, trans, light emitting, mirrored, textured, bumpy, and others.

Glazing surfaces can be either transparent (image preserving), perfectly diffuse, something in between, or described by a BSDF distribution.

Exterior Modeling:

Exterior surfaces can be included. Windows may be considered using a computed candela distribution (using mkillum) or may simply be treated through its material properties.

Electric Lighting:

Luminaire Information:

Radiance has the ability to apply IES photometry files through ies2rad.exe.

Control Strategies:

Radiance does not address photosensor control in response to available daylight levels.

Control Zones:

N/A

Photosensor:

N/A

Occupancy Schedules:

N/A

Shading Devices:

Shade Type:

The program allows for any geometry to be used. Shade materials may be opaque, perfectly diffuse, or may be constructed of any available Radiance material, including materials that apply BSDF data.

Control Strategies:

Shades can only be considered as part of a standard room model.

Window Control Groups:

N/A

Simulation Parameters:

A wide variety of Radiance parameters can be adjusted. These relate to the number of bounces to consider, the number of rays to be spawned and how they are treated at reflecting surfaces, or when directed toward light sources.

Windows can be modeled using a photometric distribution that has been computed based on light arriving from all exterior sources and exterior reflecting surfaces.

Analysis points are entered via a formatted ASCII (text) file.

Output:

Metrics:

Metrics considered include illuminance, luminance, and a variety of different glare metrics. Daylight glare calculations are permitted. Photorealistic and falsecolor (pseudocolor renderings) are also possible, along with contour lines along surfaces. Numerical data generally is not highly formatted.

No Annual daylight metrics are available with the standard program.

Renderings:

Renderings can be visual or pseudocolor. Scripts can be written to compute animations.

Reference:

http://radsite.lbl.gov

SkyCalc

Cost:

Free.

Weather Data:

Weather File:

Weather data for a selection of cities across the U.S. and a larger number of California sites are available for use with the program.

Sky Type:

Individual sky types are not available.

Daylighting Method:

Sidelighting:

Not available.

Skylighting:

A single set of uniformly arranged skylights is permitted, since the space is assumed to be uniformly illuminated with daylight from a skylight system.

Geometry and Materials:

Geometry:

Only a rectangular space with a flat ceiling is permitted.

Complex Facades:

N/A

Materials and Glazing types:

Diffuse glazing is assumed. Both visible transmittance (VT) and solar transmittance (SHGC) are required. U-factor is also required for HVAC load calculations.

Exterior Modeling:

No exterior obstructions can be considered.

Electric Lighting:

Luminaire Information:

Only w/ft^2 are required.

Control Strategies:

The type of control (multi-level switching, dimming, etc.) can be selected from the user, or a customized control configuration can be entered.

Control Zones:

The fraction of the electric lighting load being controlled can be entered.

Photosensor:

N/A

Occupancy Schedules:

An occupancy schedule can be selected and/or entered into the program.

Shading Devices:

N/A

Shade Type:

N/A

Control Strategies:

N/A

Control Zones:

N/A

Simulation Parameters:

The program utilizes the Lumen Method of Toplighting. No parameter settings can be modified, although skylight properties can be modified.

Output:

Metrics:

Annual energy savings (heating, cooling, lighting) as well as average illuminance data for each month and each hour of the day are presented.

Renderings:

N/A

SkyVision

Cost:

Free

Weather Data:

Weather File:

SkyVision makes use of climate data to select the appropriate sky type from the six standard skies listed below.

Sky Type:

(1) Uniform overcast sky that corresponds to dark thick clouds
(2) CIE overcast sky
(3) CIE average intermediate sky
(4) IESNA partly cloudy sky
(5) CIE clear sky for industrial areas (with high air pollution)
(6) CIE clear sky for rural areas (with low air pollution)
(7) Dynamic based on sky brightness or illuminance

Daylighting Method:

Sidelighting:

SkyVision does not allow for the computation of sidelighting installations.

Skylighting:

SkyVision was developed for the purpose of predicting skylight performance. The program allows for the input of up to 50 skylights per building.

Geometry and Materials:

Geometry:

SkyVision allows for geometry creation within the program. The geometry is simple, only allowing for rectilinear spaces.

Complex Facades:

The composition of the skylight area can be complex. The program allows for the height of the well and the curb. The program includes five different types of skylight shapes:

(1) Dome-like (2) Cone-like (3) Vault-like (4) Light pipe (5)Flat

Materials and Glazing types:

Surface reflectances can be selected for the interior room surfaces. The glazing type can be selected from a database of included products or from a user created product added to the database.

Exterior Modeling:

SkyVision is not capable of considering exterior modeling obstructions.

Electric Lighting:

Luminaire Information:

N/A

Control Strategies:

The program offers on/off auto or continuous dimming control. Power density and illuminance level are the only entries for the electric lighting system.

Control Zones:

Photosensor:

Occupancy Schedules:

Shading Devices:

Shade Type:

Shade types with simple properties are created within SkyVision. Properties include transparency, position, and other optical properties depending if the shade is open or closed.

Control Strategies:

The control strategies allowed by SkyVision are time clock, on/off auto, and adaptive.

Control Zones:

The shades are controlled in one zone.

Simulation Parameters:

No adjustments are permitted/possible.

Output:

Daylighting Metrics:

The program calculates the total illuminance on all room surfaces. The program also returns daylight factor for all surfaces for specific sky conditions. Monthly and annual electric lighting energy savings can also be returned from SkyVision.

Renderings:

SkyVision does not produce photorealistic renderings of the space.

Reference:

http://www.nrc-cnrc.gc.ca/eng/projects/irc/optical-characteristics/software.html

Spot

Cost:

Free

Weather Data:

Weather File:

Spot makes use of annual weather data.

Sky Type:

Spot considers CIE clear and overcast skies as well as Perez skies for use in annual energy and photosensor system performance calculations.

Daylighting Method:

Sidelighting:

Spot allows for up to 10 sidelights per façade.

Skylighting:

Spot allows for up to 10 skylights per façade.

Geometry and Materials:

Geometry:

Spot uses simple geometry created within the program.

Complex Facades:

Spot does allow for wall thickness and mullions to be used.

Materials and Glazing types:

Surface reflectances can be selected for the interior room surfaces. The transmittance for each glazing unit can be selected individually.

Exterior Modeling:

Spot is not capable of considering exterior geometry in its analysis.

Electric Lighting:

Luminaire Information:

Spot allows for the use of ies files.

Control Strategies:

Complex control strategies make use of time clocks or photosensor control.

Control Zones:

Spot allows for up to 4 control zones per room.

Photosensor:

SPOT was designed for use with photosensors. The name SPOT is short for Sensor Placement + Optimization Tool. The program was designed to determine how well a photosensor works in a given location. Photosensor distributions can be entered.

Occupancy Schedules:

Complex occupancy schedules can be created within SPOT.

Shading Devices:

Shade Type:

SPOT allows for the use of blinds, shades and light shelves.

Control Strategies:

The shading devices can be controlled with a timer, automatic photosensor control, or manually.

Control Zones:

Multiple shading zones can be created within SPOT.

Simulation Parameters:

The Radiance simulation parameters, including the number of bounces, can be adjusted within SPOT.

Output:

Metrics:

Annual metrics include:

- Annual Daylight Illuminance Files
- Average Daylight Autonomy
- Average Maximum Daylight Autonomy

CHPS and LEED Daylight compliance

Renderings:

Renderings of the space can be created within SPOT using Radiance.

Reference:

http://www.archenergy.com/SPOT/

Visual

Cost:

$100

Weather Data:

Weather File:

None

Sky Type:

None – Visual does not perform daylight analysis

Daylighting Method:

Sidelighting:

N/A

Skylighting:

N/A

Geometry and Materials:

Geometry:

Geometry can be input from a DWG or DXF file. It must be converted from a background surface to a solid within the program since all CAD input is initially assigned to the background layer.

Complex Facades:

Rooms can be complex.

Materials and Glazing types:

Materials can be diffusely reflecting or transmitting.

Exterior Modeling:

N/A

Electric Lighting:

Luminaire Information:

IES photometry files are accepted, along with LDT, CIB, TMS, or CB1.

Control Strategies:

N/A

Control Zones:

N/A

Photosensor:

N/A

Occupancy Schedules:

N/A

Shading Devices:

Shade Type:

N/A

Control Strategies:

N/A

Window Control Groups:

N/A

Simulation Parameters:

Simulation parameters cannot be adjusted within Visual.

Output:

Metrics:

Illuminance, Luminance, Exitance and Irradiance can be computed.

Renderings:

N/A

Reference:

http://www.visual-3d.com/

Appendix A - Importing Revit models into Ecotect for Daylighting Simulations

There are two methods for importing geometry from Revit into Ecotect; Drawing Exchange Format (DXF) and Green Building XML (GBXML). There are benefits and shortcomings to each approach. The main consideration is the level of detail provided in the resulting space information model.

The DXF geometry file exported from Revit contains a series of triangulated surfaces. This file can be imported in two ways; as triangles or as merged surfaces. When importing as triangles the model will contain a greater number of surfaces, which can be cumbersome if minor modifications are necessary within Ecotect. Merging the triangles together to retain the rectilinear surfaces is a time consuming process. Ecotect attempts to assemble the pieces back together like a puzzle. Increased surface complexity leads to a higher chance of the surfaces not being joined together correctly. Models may contain holes in walls after this process. The main benefit to using a DXF file is that all geometry will be imported. Exterior wall thickness, shading systems, and ground planes can all be imported into Ecotect with use of a DXF file.

The GBXML geometry file is a simplistic model of the space. Rooms must be created and tagged in Revit in order to create a file for a single space. The rooms are comprised of ceilings, floors, and walls. Within the walls, the model may contain windows and doors. The exported geometry is a simplistic reproduction of those rooms. Interior components such as exposed columns will not be exported. The model also does not carry the ground plane outside or the thickness of the exterior wall. No exterior shading devices are exported. While this method improves calculation time, the results of a daylighting analysis computed with this model may not be accurate due to the simplifications and missing components.

One way to achieve the benefits of both methods is to create both files types with some minor adjustments. The interior room geometry can be created using the GBXML file. This will ensure fast computation times. To include the exterior geometry, columns, and other intricate geometric elements, the user can then apply the DXF file. Both of these models are then imported into Ecotect. The daylighting analysis will be faster than if only the DXF file was used, but will be more accurate than the GBXML file input.

Revit to Daysim Conversion

This section describes the Revit to Daysim conversion process for conducting detailed daylighting calculations in Ecotect. The first step is to save the Revit file to a CAD standard while in a 3D view. This file must then be opened in AutoCAD. Numerous changes must then be made to prepare the model for use in Daysim. This process includes deletion of unnecessary geometry, simplification of window systems, and subdivision of floor surfaces. Once this manipulation is complete, there are two more steps required to import the model into Daysim.

Many times, models that are designed in Revit contain geometry that is not needed in an architectural lighting model. Most common are entities of the mechanical system, hidden structural elements, and decorative elements on the building. These items should be removed from the model to aid in the

refresh of AutoCAD views and to reduce the simulation time in Daysim. This is an important time saving step, although maintaining these features would not negatively impact the calculation results. The model can then be purged of all layers that will not be used to make material file creation easier.

The simplification of a window system is important for the accuracy of the results. Models typically come with surfaces that address each individual pane of glass. This is a problem for Daysim, which is built on the Radiance calculation engine. With a transmittance of 50%, a double-surface window would simulate as 25% transmittance. At times, this is difficult to notice as systems usually appear as blocks. These blocks must first be exploded into their individual parts so they can then be manipulated. The blocks must also be exploded or they may not show up when simulating the model.

Floor surface subdivision is important for working with the model once in Daysim. Each room being simulated should have its floor on a separate layer. This allows a user to select that layer as the calculation grid. This not only allows for quicker calculation times, but easier display of the results. Instead of viewing a whole building floor plane, individual rooms will appear on the results screen.

To convert the file from an AutoCAD type to a Radiance .RAD file for use in Daysim, the file must be saved as a DXF type. The DXF file can then be passed through a simple DXF2RAD program to obtain the a text-based geometry file. This simple format is the input needed for Daysim. In addition to this geometry file, a material file that contain a material description for each layer must be created for the program to function. This file holds the material properties for light interaction.

This process is a lengthy one, but is the only way to ensure the model contains the proper information for simulating the space. A more automatic conversion process is needed to make daylighting simulations easier to perform. It should be noted that this is also a one-way process – any changes made in these secondary models cannot be used to update the original Revit model directly. Any later changes to the geometry implemented by the architect will also require the daylighting modeling to repeat this process to update the model in order to conduct a revised simulation.