4.401/4.464 Environmental Technologies in Buildings – Assignment 5

Instructor: Christoph Reinhart

Due Date: Friday of week 7

Type: This is a group assignment.

Daylight Availability Study

In this assignment you will start working in groups on your final course project which is the development of an environmental design concept for an about 3500m^2 innovation/startup space located in either Chicago, Houston or Seattle, depending on which city you previously signed up for. Your building should accommodate work spaces for around 250 workers, a reception area, lavatory, two seminar rooms and a cafe (optional). It is up to you to define the final program. You may pick any available site within your city and should also consider external factors such as a site's walkscore etc. Remember to include neighboring buildings in your shading and daylighting analysis. The goal of this first assignment is to develop and evaluate a series of massing options and façade designs that you will then further refine in future assignments.

Task 1: Site selection and climate analysis

As a first step browse different vacant lots throughout your city and pick a site. For your selection it does not matter whether the site is actually for available for development. However, you should come up (and state) with a few reasons supporting your choice. These reasons may range from proximity of other businesses or educational facilities to access to public transportation. Create a simple massing model of the surrounding buildings and evaluate the annual external shading situation for your site using sun path diagrams and/or radiation maps. Formulate three to four guiding principles for your design.

Task 2: Daylight massing study

Explore at least three different massing variants on your site with a generic window to wall ratio of 40%, calculate the spatial daylight autonomy ($sDA_{300lux}[50\%]$) for all three variants and decide which variant you want to continue working on going forward. Show visualizations of your $sDA_{300lux}[50\%]$ calculations and report the percentage of your building that is "daylit."

Task 3: Window-to-wall ratio study

For your favorite massing variant from Task 2, explore at least three different window and skylight configurations to see in how improve the daylight availability throughout all

regularly occupied spaces within the building. Possible interventions include changing window sizes and positions as well as adding light shelves or blinds. Discuss your findings.

Simulation Assumptions

Make sure that your Rhino file units are in meter. For the outside ground assume a reflectance of 20%. For interior surfaces, assume 50% for walls, 20% for floors and 80% for ceilings. You may pick any glazing type of your liking. The grid of sensors should be 0.85m above the floor with a spacing of 0.5m. Simulation parameters should at least be ab = 4 and ad =1500 (see also the simulation checklist below).

Table: Daylight Simulation Checklist.

Before you start	Did you decide which daylighting performance metrics to simulate and how to interpret the results?
	Do you have a general idea of what the results should look like? E.g. a mean daylight factor in a standard sidelit space should lie between 2% and 5%; interior illuminance should lie between 100 lux and 3000 lux and daylight autonomies should range from 60% to 90% throughout the space.
	Have you verified that the simulation program that you intend to use has been validated for the purpose that you intend to use it for, i.e. that the simulation engine produces reliable results *and* that the program supports the sky models related to your performance metric of choice? (An example would be the old CIE overcast sky for daylight factor calculations.)
	Have you secured credible climate data for your building site? (This is only required for climate-based daylighting performance metrics.)
Preparing the Scene	Did you model all significant neighboring obstructions such as adjacent buildings and trees?
	Did you model the ground plane?
	Did you model wall thicknesses, interior partitions, hanging ceilings and larger pieces of furniture? Try to model all space dimensions at least within a 5cm tolerance. Façade details should be modeled with a 2cm tolerance.
	Did you consider window frames and mullions by either modeling them geometrically or by using reduced visual transmittances for windows and skylights?
	Window glazings: - Did you check that all window glazings only consist of one surface? Several CAD tools model double/triple glazings as two/three closely spaced parallel surfaces whereas daylight simulation programs tend to assign the optical properties of multiple glazings to a single surface.

	- Did you check that all windows are 'inserted' into the wall planes and not "overlaid" on the wall surfaces? Several CAD tools suggest that you can create and visualize a window in many different ways, one simply being the placement of a window surface on top of a wall surface which case end up with two coplanar surfaces. As a result the simulation program will either ignore the window or somehow 'guess' which surface to consider.
	Did you assign meaningful material properties to all scene components?
	Did you model any movable shading devices such as venetian blinds? If yes, do the results make sense?
Setting up the simulation	Make sure that you set up your project files correctly. This may involve: - Checking that your project directory and file names do not contain any blanks (" "). - Verifying that all sensors have the correct orientation, i.e. work plane sensors are facing up and ceiling sensors are facing down. - Setting the resolution of the work plane to 0.5m x 0.5m or 1ft x 1ft and placing it around 0.85m above the floor. - Selecting simulation parameters that correspond to the 'scene complexity'. To do so you should consult the technical manual of your simulation program. - Selecting the correct sky model (CIE, Perez, etc.).

*) For a scene of low complexity (typical sidelit space with a standard window) the Radiance simulation parameters should be: ab= 4; ad =1500; ar=100, as=20; aa = 0.1; av=0 0 0.

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