The impact of late design choices on interior daylight

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How could furniture be the reason you think it is just a little too gloomy at work? We studied how much different late design choices are affecting the interior daylight and energy use in buildings and found that furniture and window characteristics are among the most influential factors.

The study included nine design choices that professionals could make or change in the late stages of a project. Sometimes it is not professionals who take these decisions at all, but instead the occupants of a building themselves. The visual transmittance of windows, namely how much light can pass through the windows, and the amount of furniture in the space were identified as the most impactful factors. Windowsill and head heights, the colour and material of furniture and the height of workspace partitions had a medium influence. Finally, colour of the floor, ceiling, and walls proved to be the least impactful late design choices. In certain situations, these late design choices could have a significant impact on the interior daylight. The average variability could be as large as 27%, depending on what daylight metric was used in the assessment. This highlights how large the variability because of such design choices is: that they have the power to make or break the interior daylight in a space.

In current practice, daylight analysis is often carried out when definitive decisions about space characteristics such as materials, colours, window characteristics and furnishing have not yet been made. We talked to industry professionals and consulted environmental certification schemes, building standards and regulations to find out which factors designers could change late in the design process and what values these factors usually take in practical settings. We also studied several daylight metrics, the measuring sticks used to assess daylight to paint a broad picture of the impact of the studied factors. This way we could find out which late design choices were more or less influential on average. Design decisions often taken early on, such as distribution of building volumes, orientation, and window-to-wall ratio, as well as environmental context such as surrounding topography, buildings and vegetation have a dominant impact on interior daylight. It has been shown by previous studies that these underlying daylight conditions influence how much the daylight is finally impacted by late design choices. To avoid misrepresentation of the analysis results we designed a set of building models to create various lighting conditions. These building models (twelve in total) were of varying orientation, size, and window-to-wall ratio. With these building models we performed daylight simulations in Honeybee by Ladybug Tools, a plugin for Grasshopper in Rhino 3D. The simulation results were fed to a global sensitivity analysis script written with the SALib package for Python. With sensitivity analysis according to the method of Morris we could determine the impact each late design choice had on the final daylight levels in each building model.

The results of the study were not as straight forward as one late design choice being the most influential across the board. It also highlighted that every building is unique, and that interior daylight is not equally affected by late design choices in all cases. To circle back to the opening statement: furniture might be one of the reasons you think it is too dark inside, or it might be the transmittance of the windows, or something else. Nevertheless, the takeaway is that in certain situations late design choices could have a quite large impact on the daylight. We believe that if architects, engineers, interior designers, and daylight specialists are aware of variability due to late design choices, they can take proactive measures to ensure the resilience of interior spaces.

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