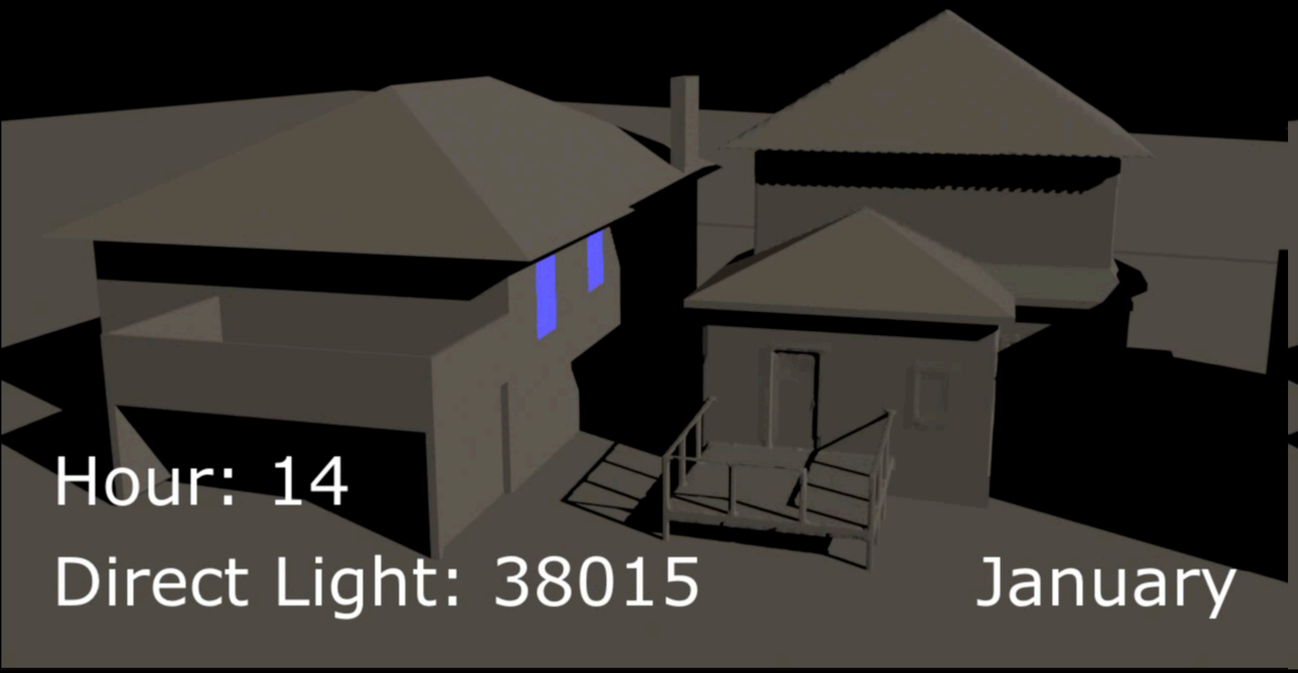
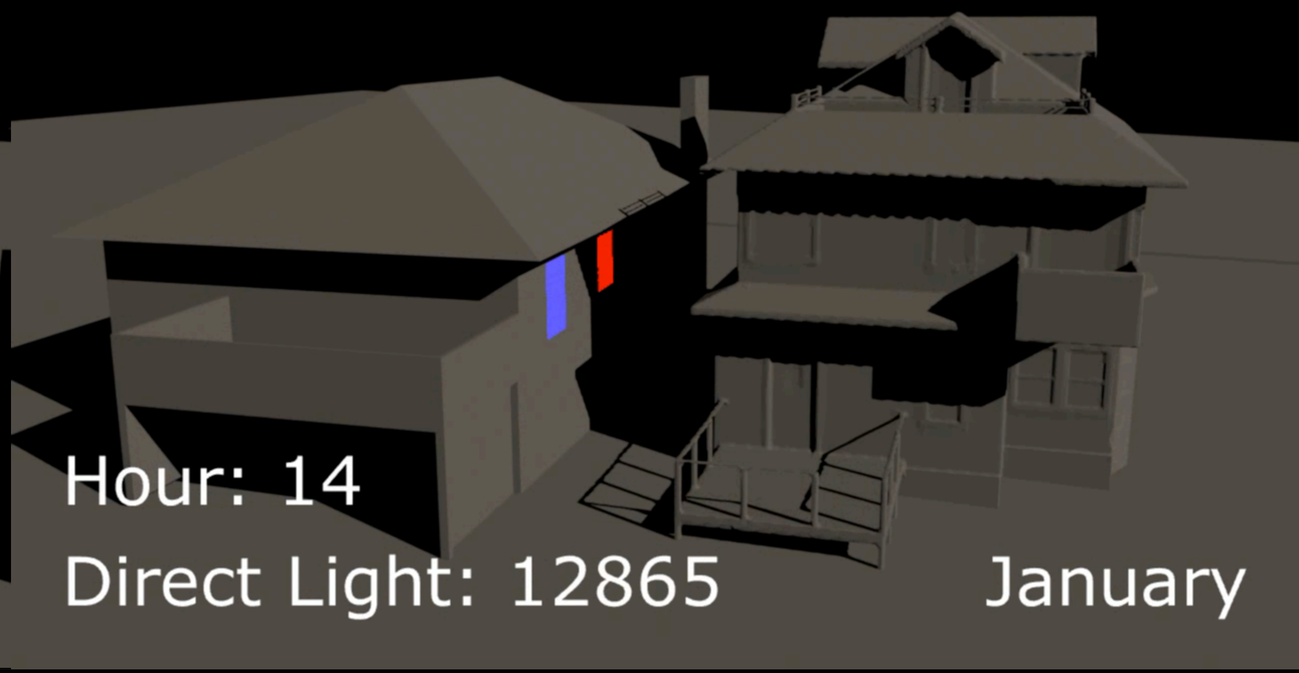
Direct Lighting Comparison

18.6% difference over the course of the year

Current Layout



Proposed Design



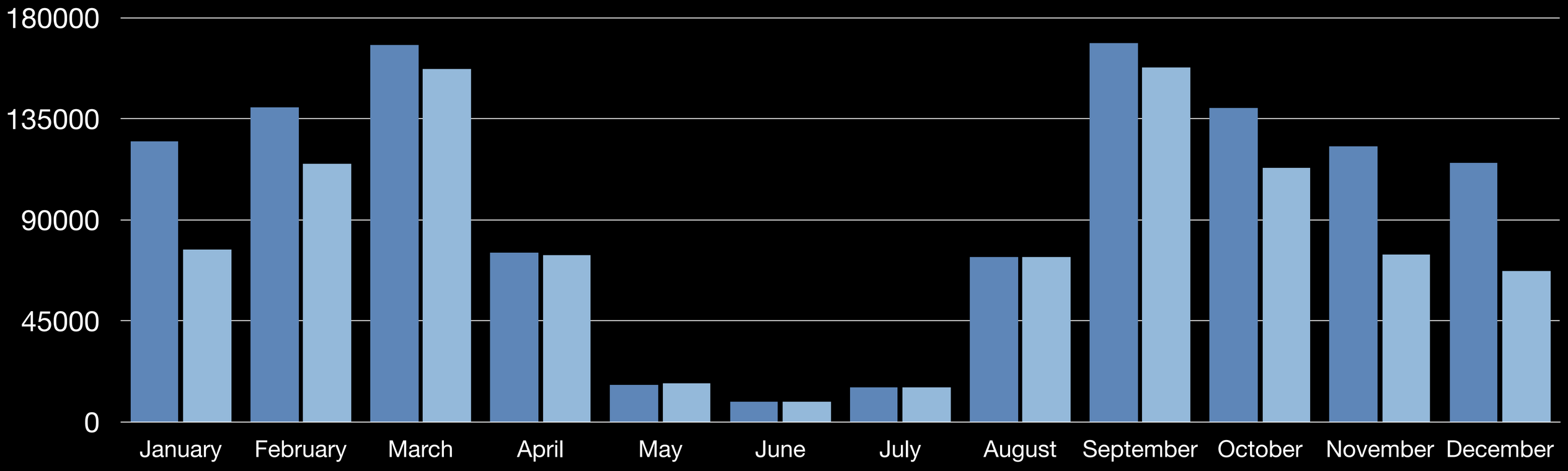
: Indicates areas on windows of concern where light is **equal** in both layouts

: Indicates areas on windows of concern where light is **less** in the proposed design

No windows that received direct light during a day goes without receiving direct light in the proposed design

Direct Lighting Comparison

Month by Month



: **Current** direct light accumulated on the windows of concern per month

: Direct light accumulated on the windows of concern per month with the **proposed** design

Global Lighting Comparison

When accounting for indirect illumination, the difference in light is only 11.3%.

Current

Proposed

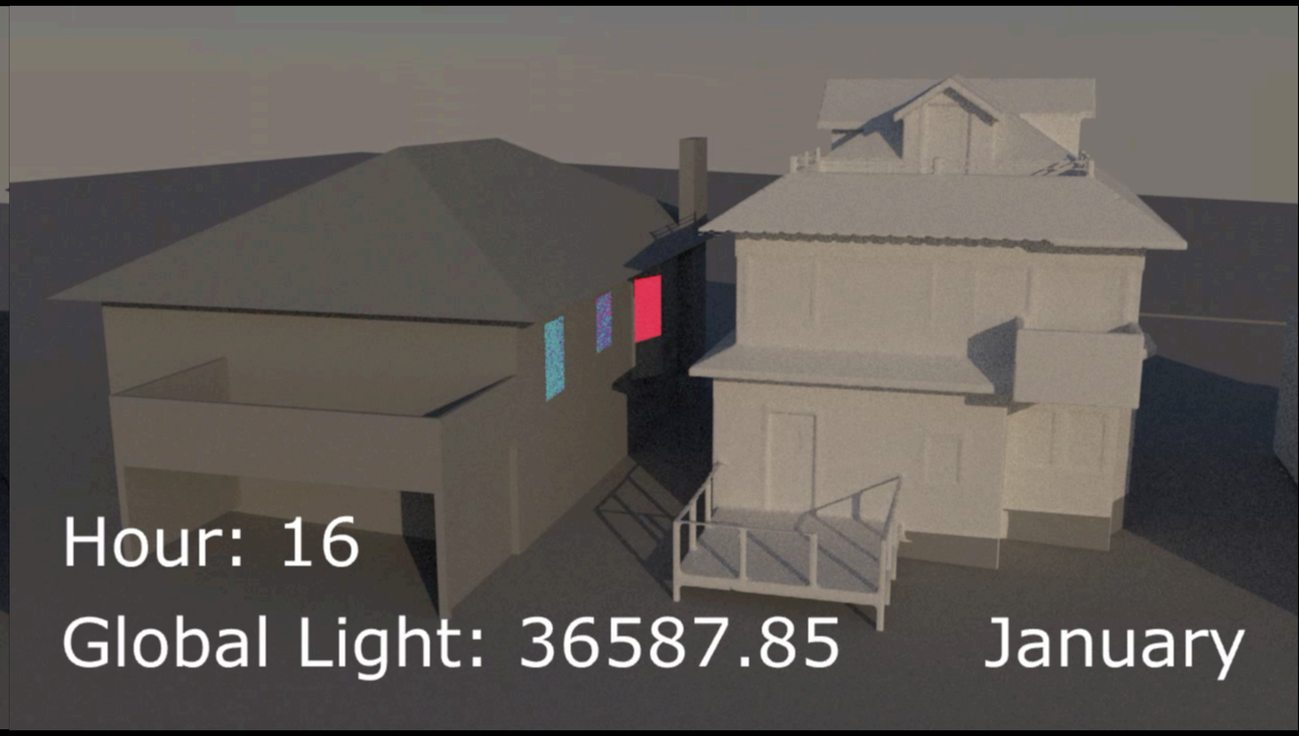
: Indicates areas on windows of concern where light is **less** in the proposed design

Global Lighting Comparison

Brightening the paint color by .49 albedo equalizes the total light (~0.08% difference)

Current

Proposed



: Indicates areas on windows of concern where light is **less** in the proposed design

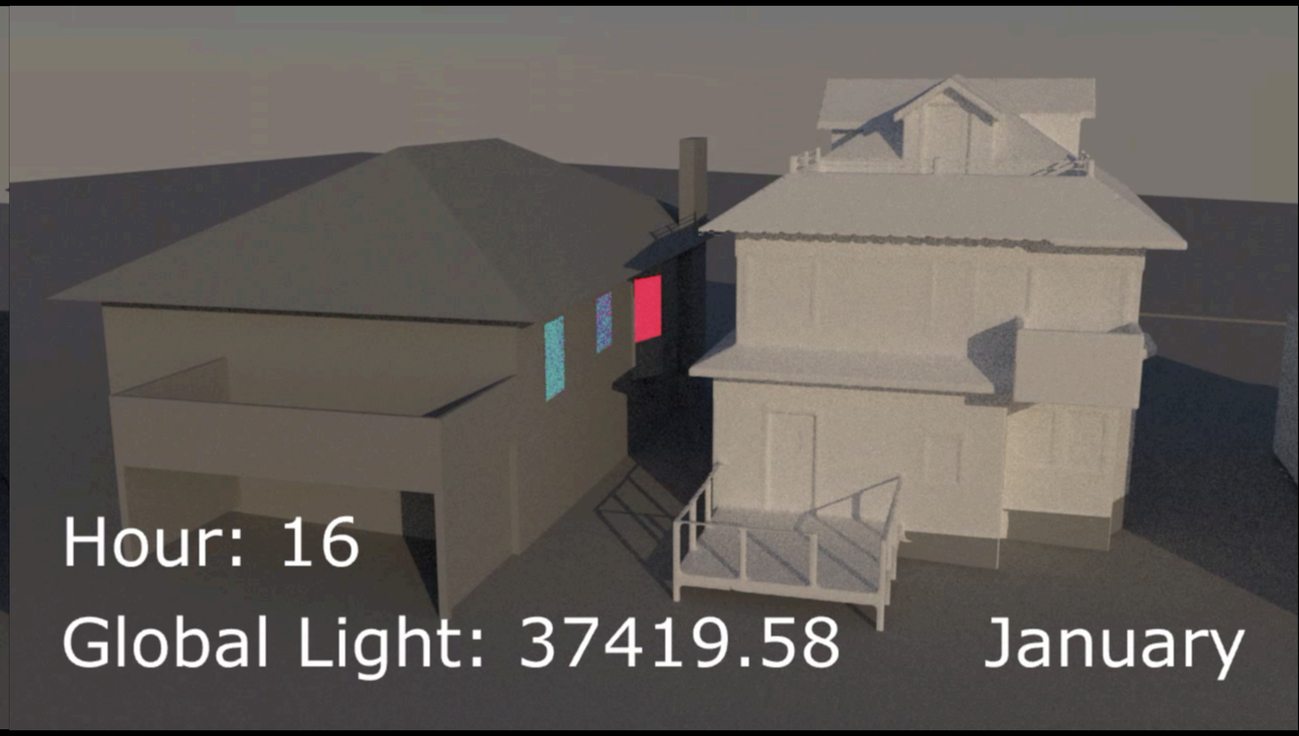
: Indicates areas on windows of concern where light is **more** in the proposed design

Global Lighting Comparison

Brightening the paint color by .6 albedo increases light to 2.54% beyond current

Current

Proposed

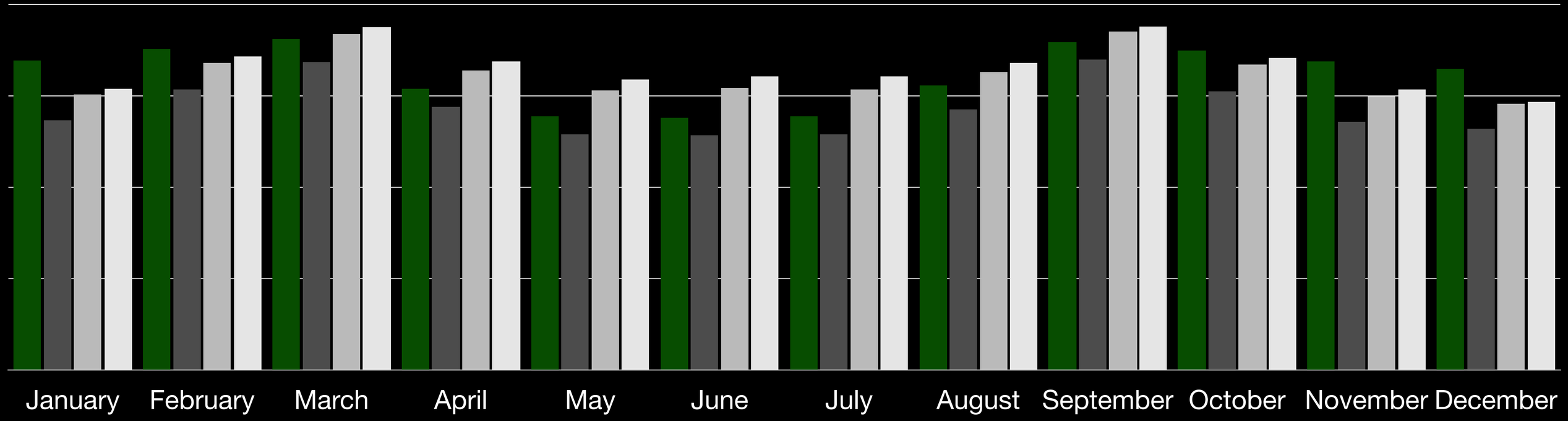


: Indicates areas on windows of concern where light is **less** in the proposed design

: Indicates areas on windows of concern where light is **more** in the proposed design

Global Lighting Comparison

Month by Month



: **Current** global light accumulated on the windows of concern per month

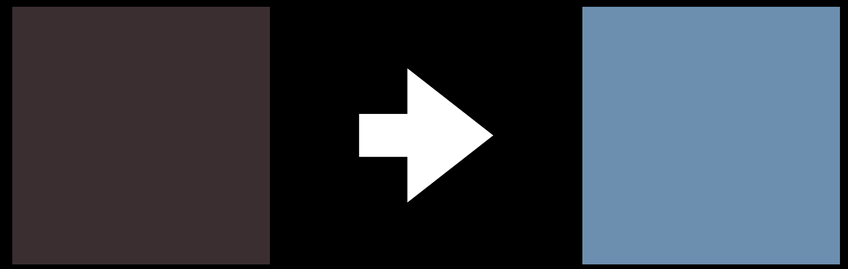
: Global light accumulated on the windows of concern per month with the **proposed** design

: Global light accumulated on the windows of concern per month with the **proposed** design and .49 extra paint albedo

: Global light accumulated on the windows of concern per month with the **proposed** design and .6 extra paint albedo

Conclusions

- No window that receives direct light during a day goes without receiving direct light in the proposed design
- The windows of concern receive 18.6% less direct light with the proposed design, concentrated in the months of November-January
- When accounting for indirect light, the difference is closer to 11.3%.
- When accounting for indirect light, paint color is highly significant. Increasing the paint albedo by .49 would compensate for lost direct light caused by the proposed design.



.2 albedo

.69 albedo

Methodology

- Architectural models were created in Trimble Sketchup, and imported into Autodesk Maya for visualization after having first been voxelized and remeshed in SideFX Houdini.
- Lighting was simulated using Pixar's RenderMan via the PxrEnvDayLight model (See citations for the papers the model was based on.)
- Lighting was simulated on the 20th of each month in 10 minute increments from 5:00 to 21:00*.
- For direct lighting, only direct light from the sun was considered.
- For indirect lighting, the full sky and 8 bounces of diffuse inter-reflection were considered.
- Derivative's Touch Designer was used for both producing the information overlays and computing the lighting totals.
- For direct lighting, the totals were computed by counting pixels on the windows of concern that received direct light for each rendered image.
- For global lighting, the totals were computed by first averaging, then summing all the pixels on the windows of concern for each rendered image.
- A diffuse material with 0.3 albedo was used a baseline and only changed for the global lighting tests that explicitly altered it.

* For the direct lighting calculations, no direct light ever reaches the windows of concern after 19:00, so only 5:00 to 19:00 was simulated.

Citations

- A. J. Preetham, Peter Shirley, and Brian Smits. 1999. A practical analytic model for daylight. In Proceedings of the 26th annual conference on Computer graphics and interactive techniques (SIGGRAPH '99). ACM Press/Addison-Wesley Publishing Co., USA, 91–100. DOI:https://doi.org/10.1145/311535.311545
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