

Experiments with a digital 'light-flow-meter' in daylit art museum e-buildings

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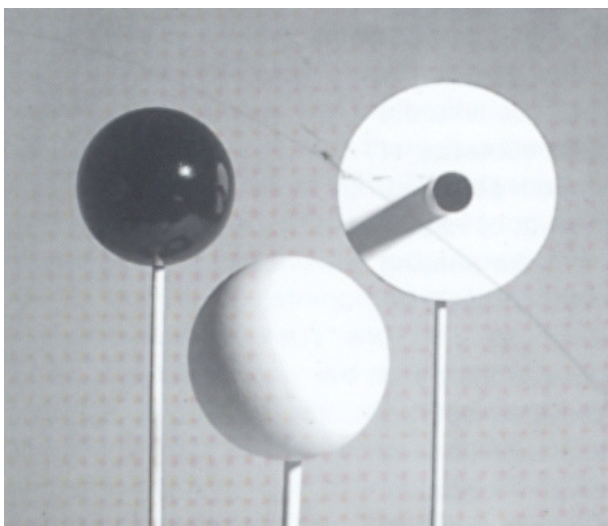
This presentation will sum up a series of experiments with a digital 'light-flow-meter' that was carried out at Victoria University of Wellington as part of a *digital craft course* in the first trimester of 2006. The 'light-flow-meter' consisted of a grid of matt white spheres that was placed vertically in a perspective section in the art museums that the students modelled as part of the course. The 'light-flow-meter' was introduced in order to explore the idea of a quick and simple tool for the visual assessment of spatial and form-giving characters of daylight. Students were required to place this meter in an appropriate daylit gallery or circulation space in their e-buildings. It was suggested that the criteria for selection of the space to 'measure' should place great emphasis on the complexity of light flow and the need for visual articulation of complex spaces. The architectural and theoretical background of the 'light-flow-meter' experiment, and the students' interpretation of its use, will be discussed as part of this presentation.

The digital craft course <http://www.vuw.ac.nz/architecture-onlineteaching/courses/bbsc303/>, which has been taught by Mike Donn for many years, aims at developing students 3D building modelling abilities. As part of the course, the students are encouraged to use Radiance to analyse the daylit art galleries. In order to use Radiance (on a School of Architecture), a long line of interfaces have been used. This year students were encouraged to use Light Studio (an alternate renderer in AutoDesk's Viz product) because the translation issues from their CAD programs were less than with Rayfront – the previous 'interface'.

The students work and websites can be seen at <http://www.reasonate.co.nz/projects>



Experiments in Light Studio



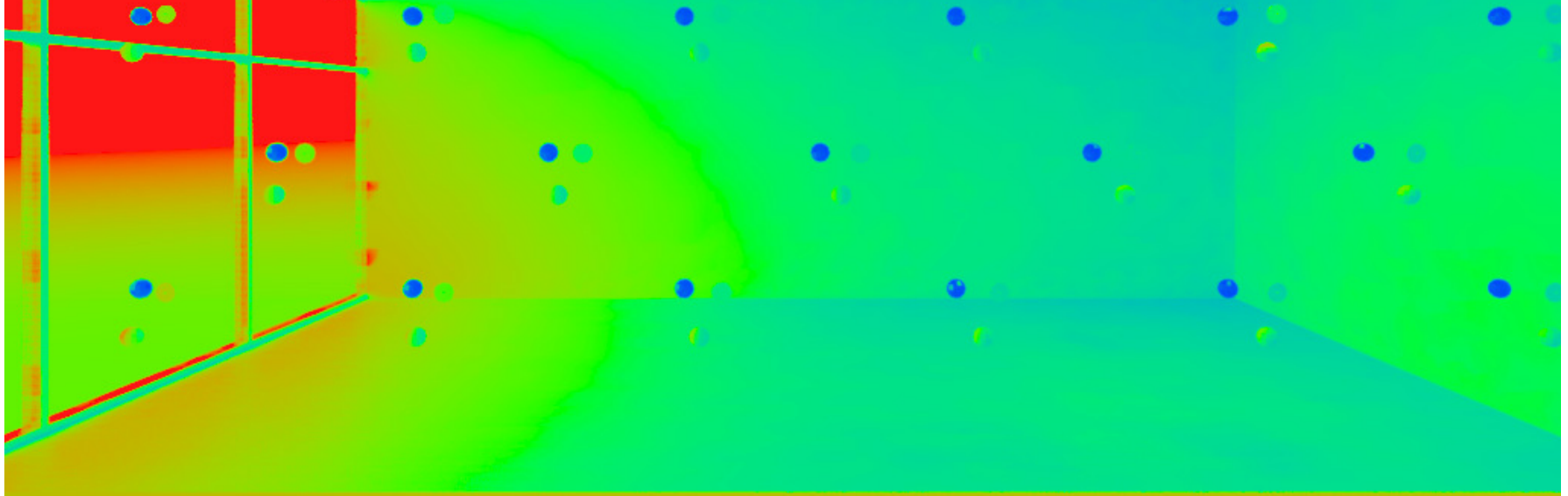
In our first experiments we worked with Kit Cuttle's physical model idea of 'three objects in a light field' - a white matt sphere, a shiny black sphere, and a gnomon on a white disc.

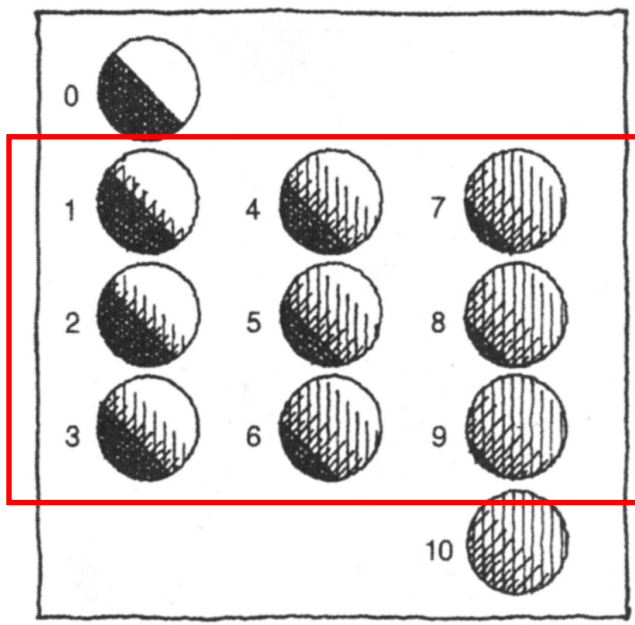
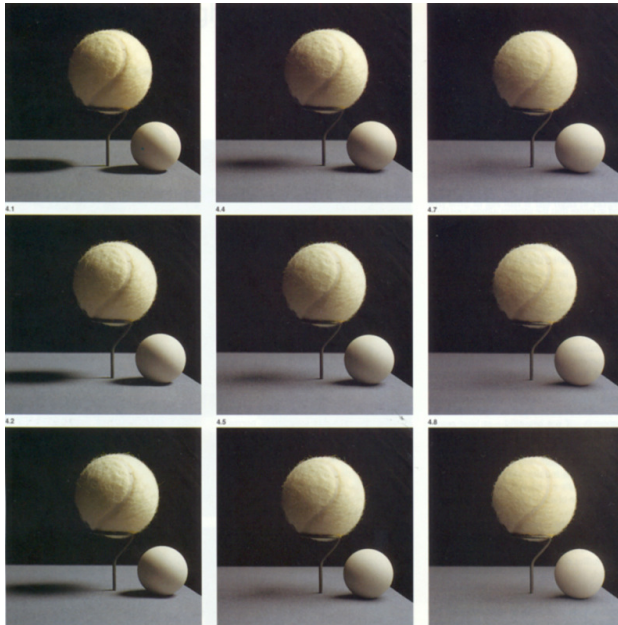
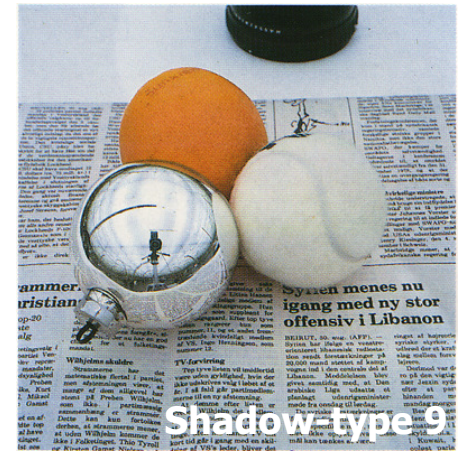
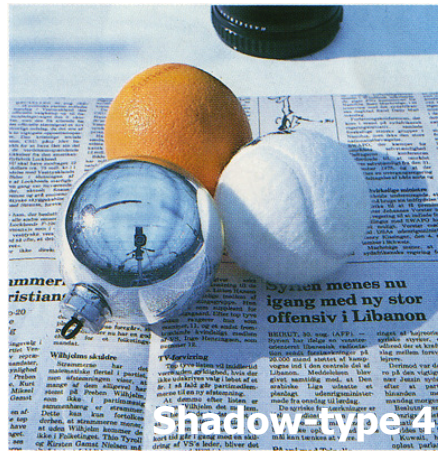
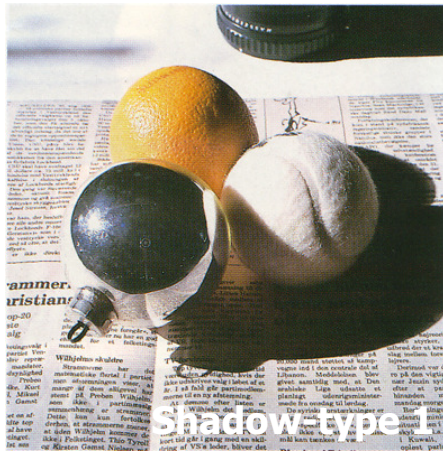
According to Cuttle's concept the following three lighting patterns constitute the 'flow of light': the *shadow pattern* (assessed from the peg on a disc), the *highlight pattern* (assessed from the black shiny sphere) and the *shading pattern* (assessed from the mat white sphere).

Source: Cuttle, C. (2003). *Lighting by Design*, Architectural Press.



While the glossy black sphere and the white mat spheres worked well, we didn't succeed in making the shadow pattern from the gnomon on the disc 'readable'. Therefore (and for simplicity) we went back to a grid of just white matt spheres as our 'light-flow-meter'.

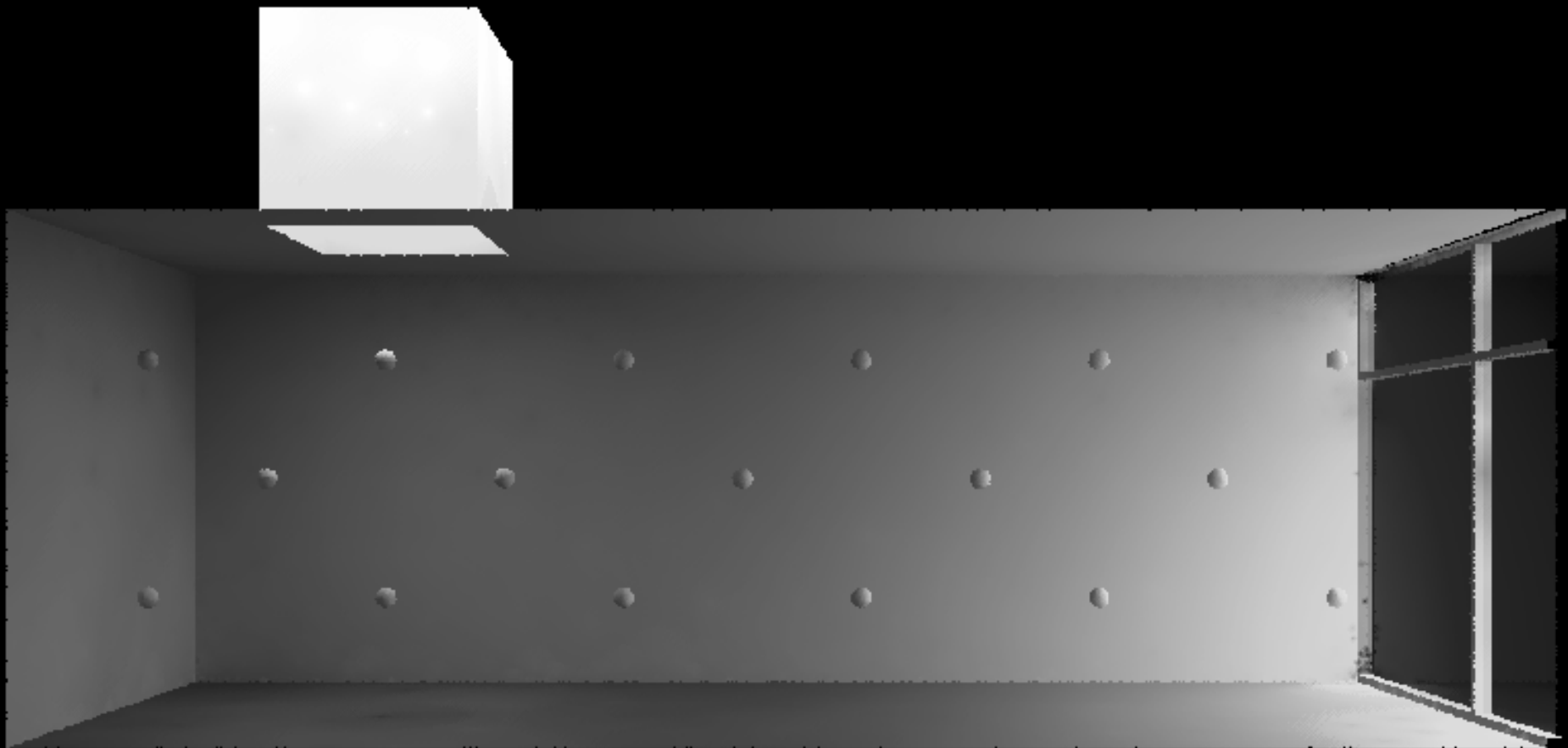




The scale of shadows

No. 0	Very sharp
No. 1-3	Hard/strong
No. 4-6	Moderate
No. 7-9	Soft/weak
No. 10	Very diffuse

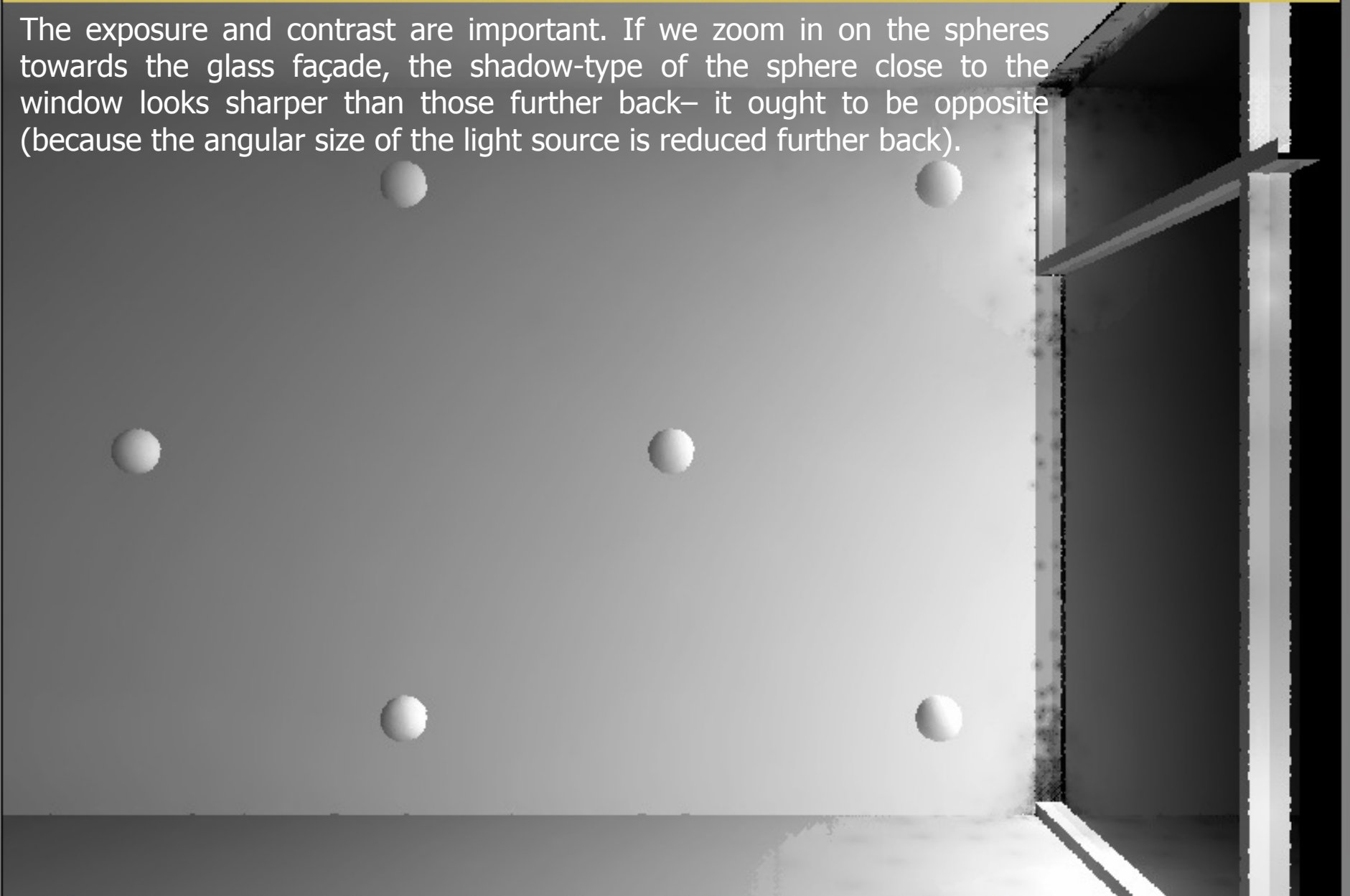
Furthermore, Cuttle's *flow of light* shows a relationship with the concept of the *Scale of Shadows*, defined by Sophus Frandsen in the article: *The Scale of Light* from *International Lighting Review*, 1987/3.



A simple rendering of the 'light-flow-meter' in a space with two daylight openings might look something like this. The *flow of light* is 'readable' in the sense that the directions of light are obvious and the shading pattern clearly different through out the space, but how assessable are the shadow-types?

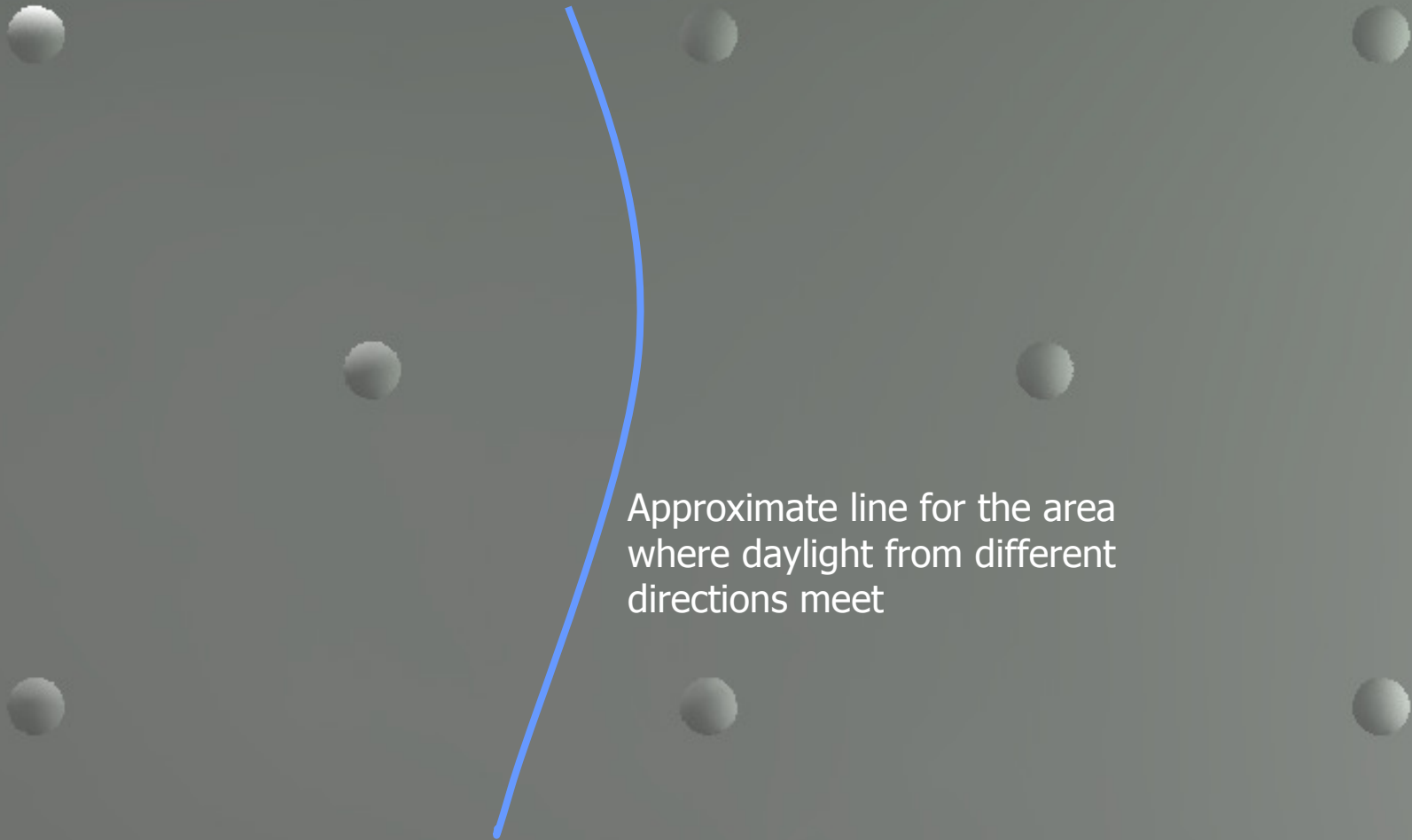
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The exposure and contrast are important. If we zoom in on the spheres towards the glass façade, the shadow-type of the sphere close to the window looks sharper than those further back— it ought to be opposite (because the angular size of the light source is reduced further back).

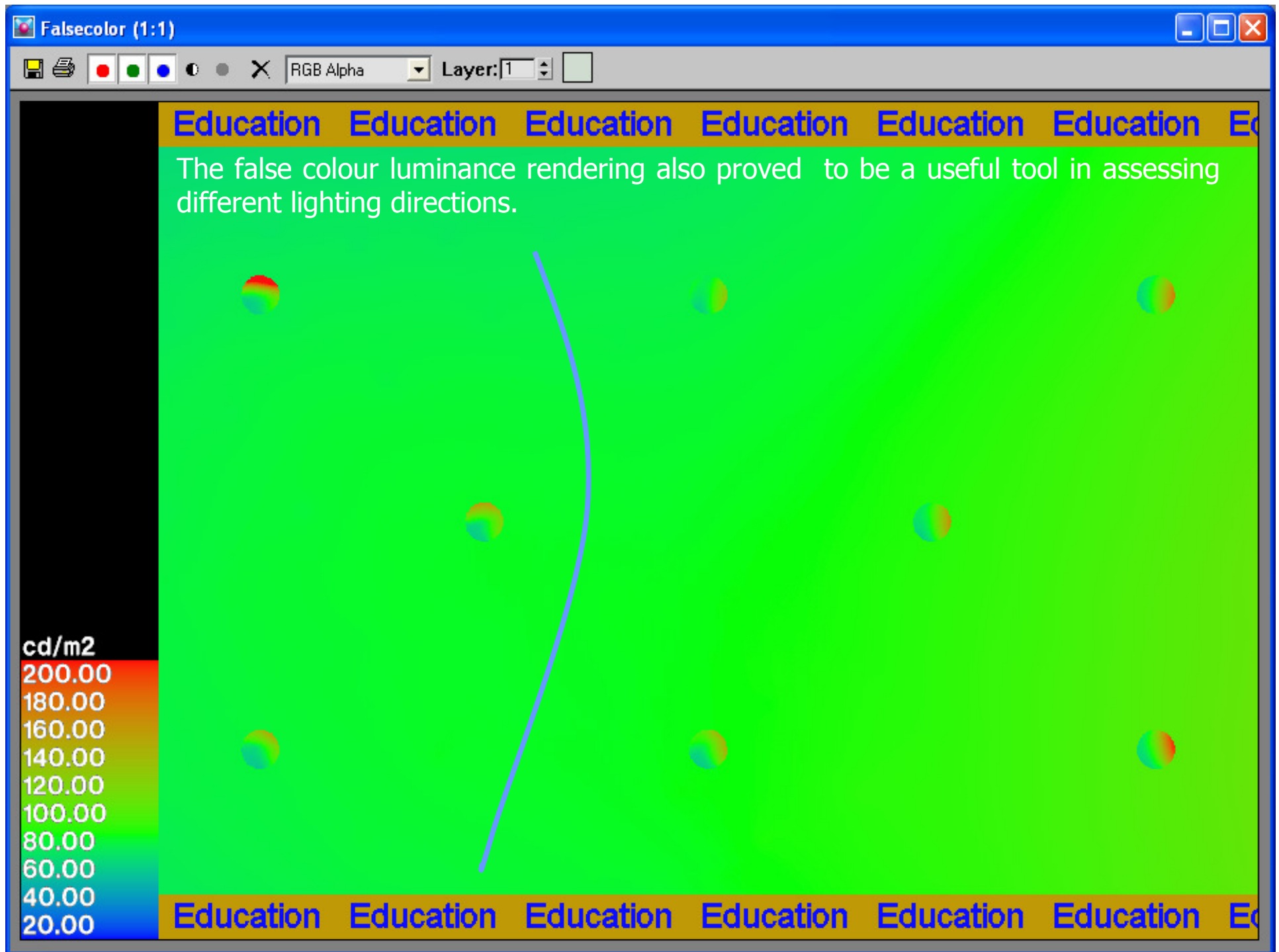


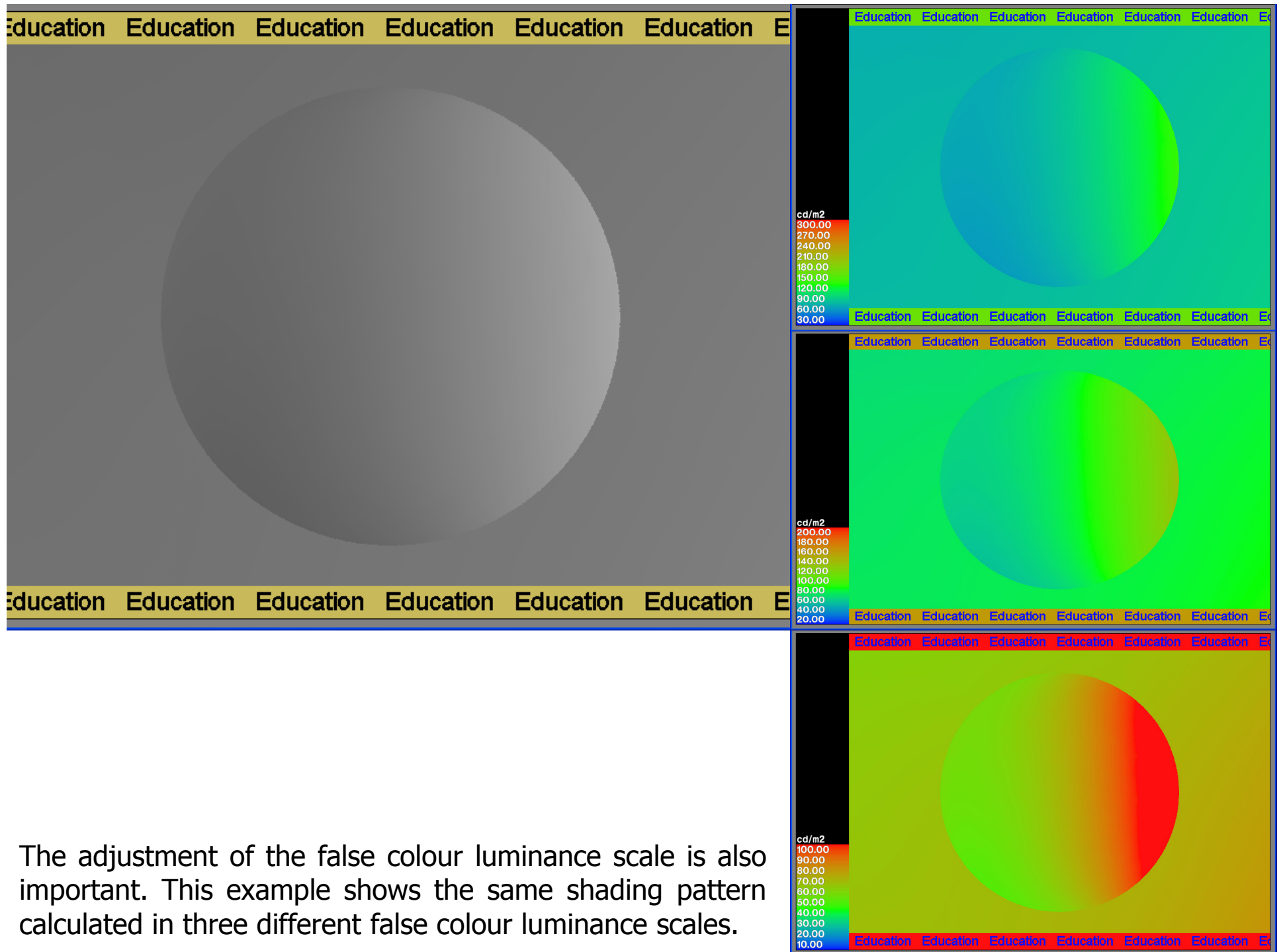
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The 'light-flow-meter' proved useful in assessing the line or area where daylight from different directions 'meet'. This area is important for the form-giving characters of light, for the 'balance' of light within the space, as well as the way people naturally move.

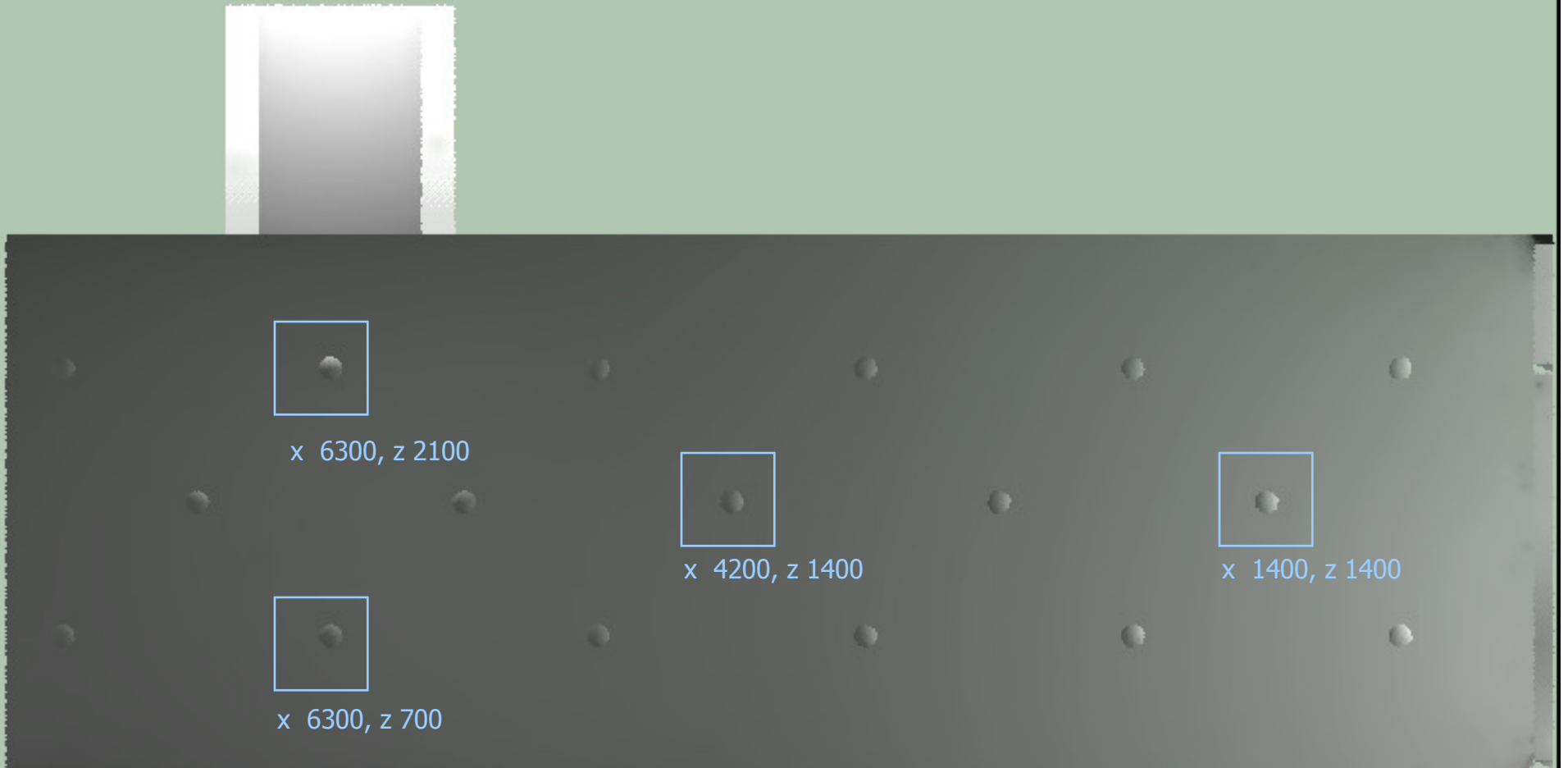


Approximate line for the area
where daylight from different
directions meet





The adjustment of the false colour luminance scale is also important. This example shows the same shading pattern calculated in three different false colour luminance scales.

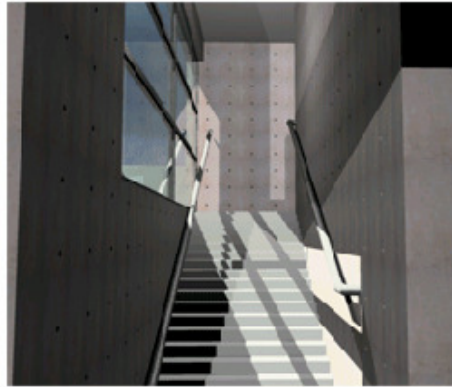


In order to eliminate the ambiguity of the shading pattern that was caused by the perspective view, we made some experiments with renderings in the parallel view type. Even though this makes the shading pattern/shadow-type more obvious, we still think it's quite hard to assess the shadow-types visually

Comparison renders



Radiosity : scanline



Radiosity : mental ray



Radiance : Lightstudio

Lightflow Meter



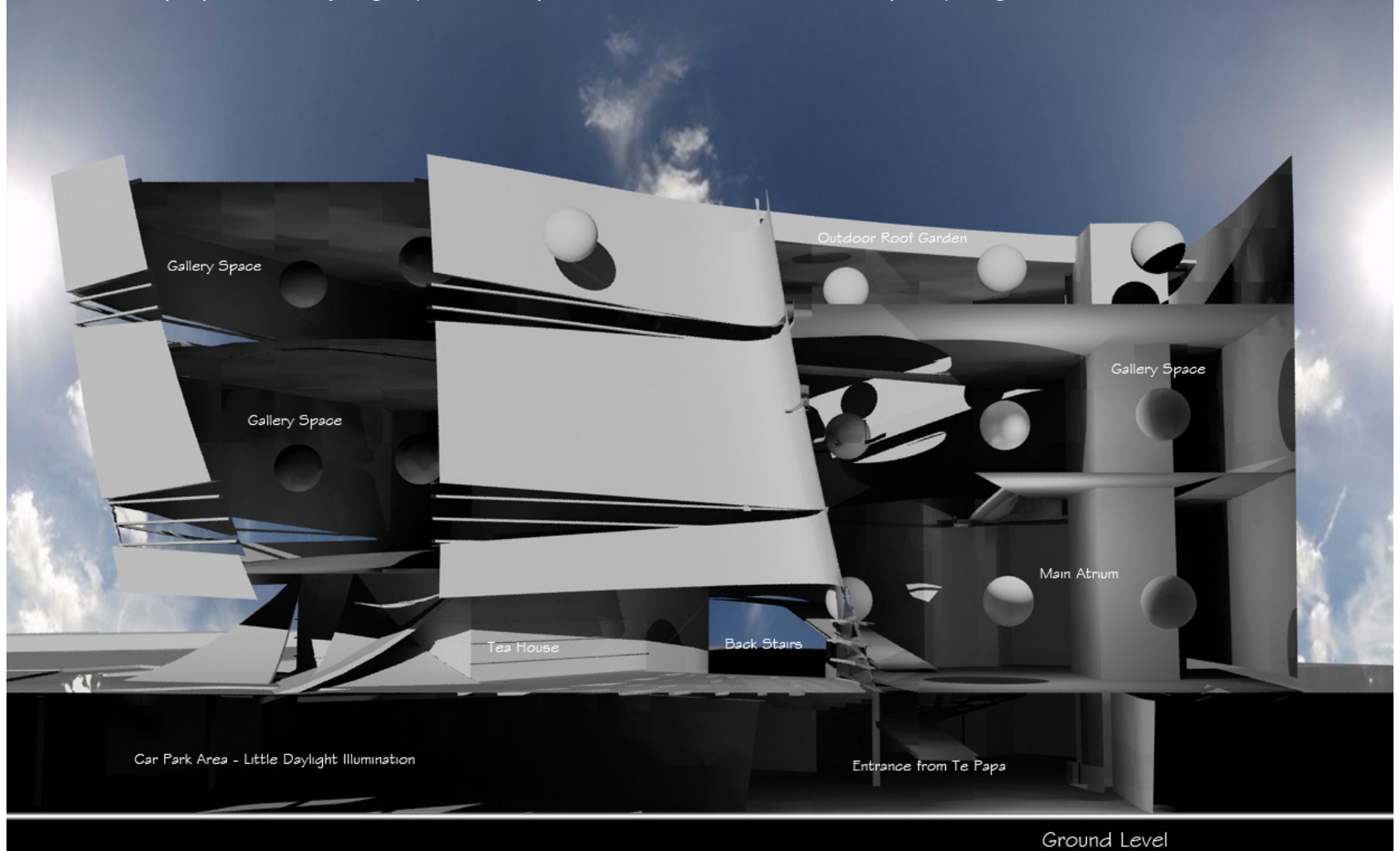
[Click here for link to HDR image.](#)

[Click here for link to Quick Time movie of lower gallery.](#)

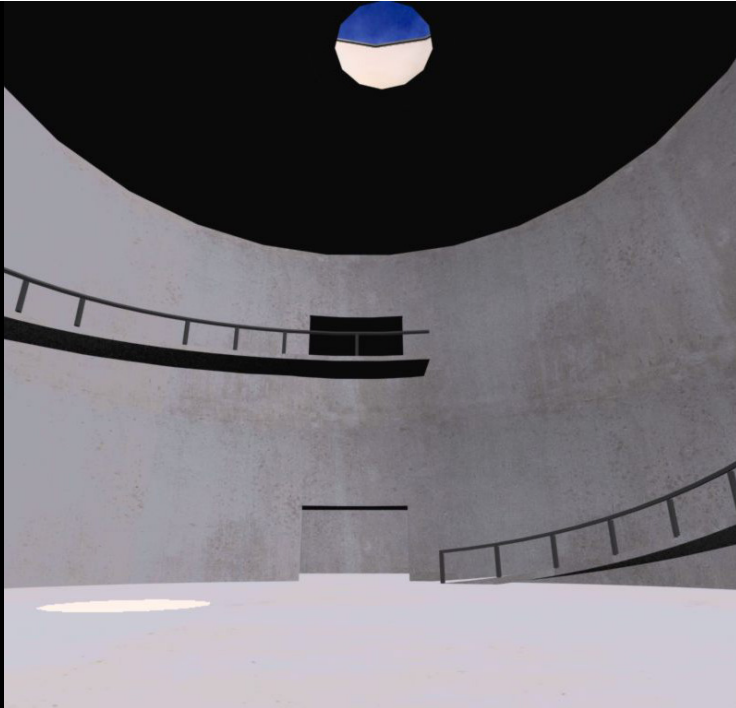
This section is cut through the upper gallery and surrounding walkways. It shows how the quality of light changes as you move from the fully daylit walkway into the gallery with a more diffused light.

Sectional Perspective with Light Meters

VIZ Rendering Engine | Rendering Time: 36mins | Final Gather: 500 | Lights: IES Photometric Sun + HDRI Sky
Map applied to Sky Light | Size of Spheres: 1m Diameter @ 6m apart | Original Size: 1800 x 1340



http://webarea.reasonate.co.nz/Nick_Owen/final_renders_home_page.html

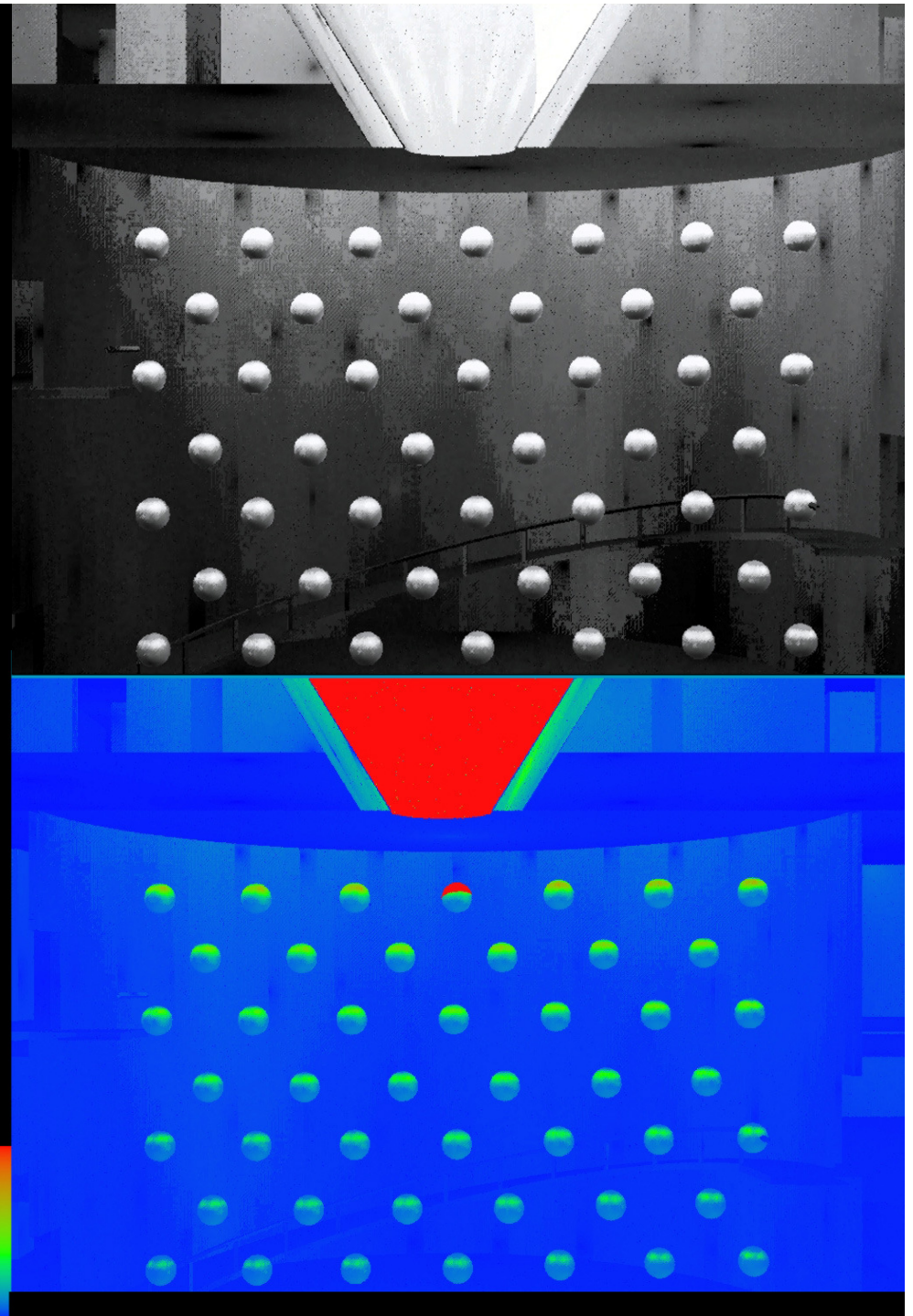


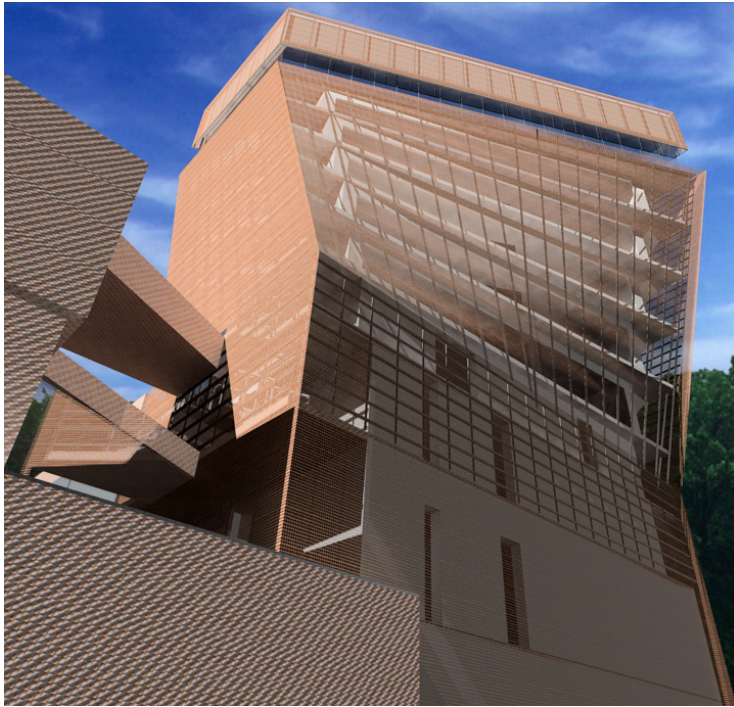
LIGHT FLOW METER

"I used the lightwell space for my light flow meter. This has an interesting flow of light into the space from above. As you get lower down in the space the natural light gradually decreases. The lightwell itself (the cone) is very, very bright as all the light is concentrated in this area and then filtered through a small hole into the main space. This is an effective space as the visitor can stand on level one and look up through to the sky. The cone also creates a circle of brighter light at the very base, adding interest to this space."

Anna Marsh

cd/m2
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00





Light Studio

Using small white spheres as a light flow meter, these renders explicitly illustrate the effect of the glazed north wall (California - north light) which provides daylight to the administration area.

A very strong and 'clear flow of light' tapers from the glazed wall deep into the interior.

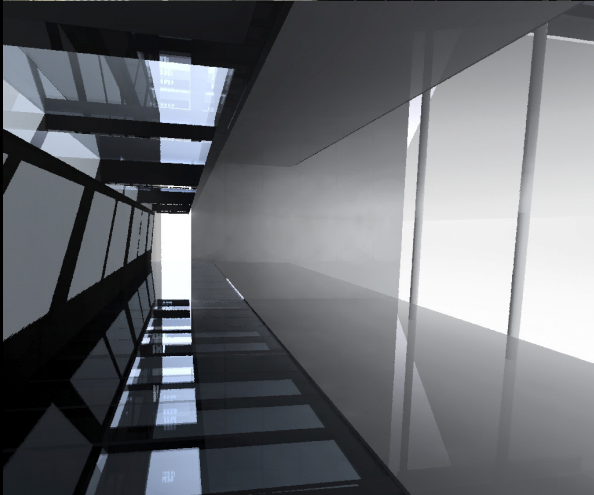
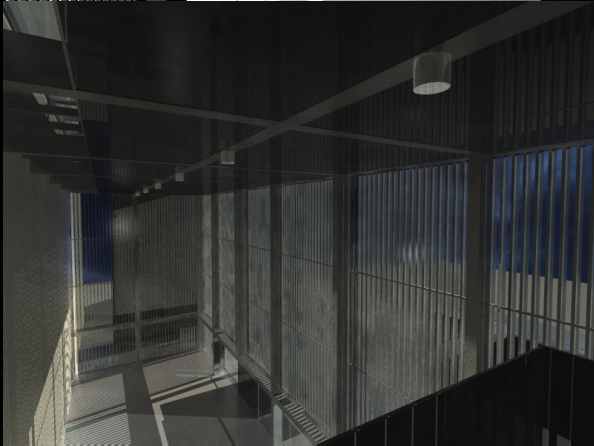
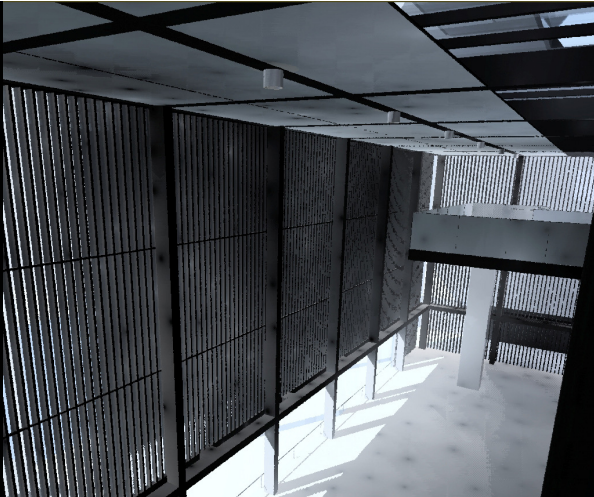
http://webarea.reasonate.co.nz/Matthew_Mitchell/final%20renders/pages/lightmeter1.html

In comparison with the administration area, the viewing level has a more even distribution of light flow. Light enters both (in fact all) sides of the viewing level as illustrated by the light meter.

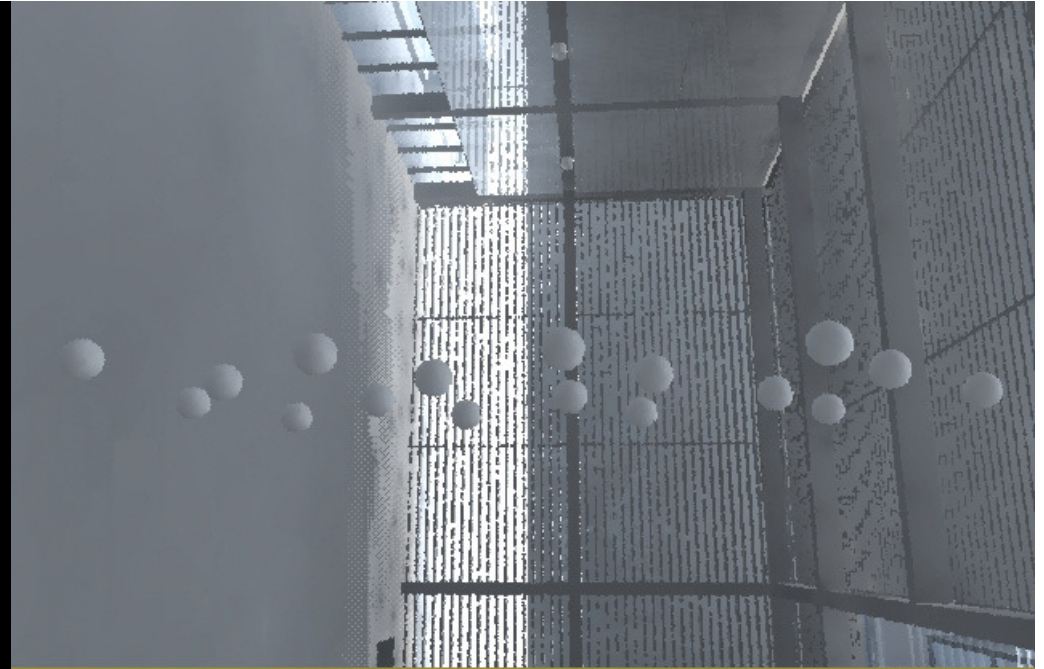
The central 'ball' of the meter has an almost even wash of light, only slightly lighter on the right (south) side - because the render was composed on an (overcast) February mid-day.

http://webarea.reasonate.co.nz/Matthew_Mitchell/final%20renders/pages/lightmeter2viewing.html

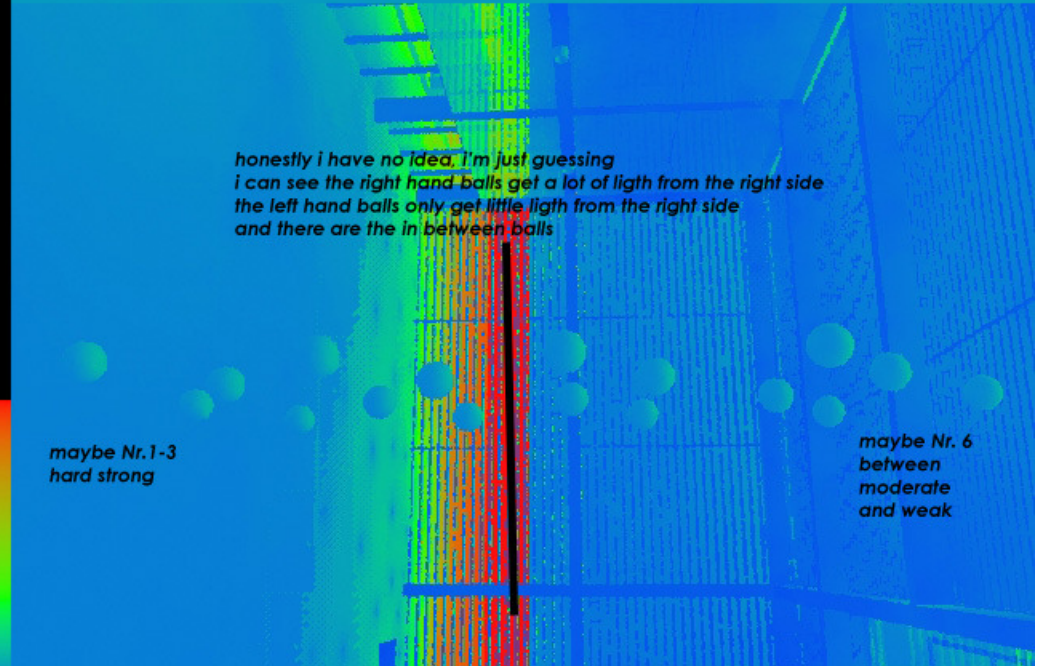
Matthew Mitchell's renderings of Swiss architects Herzog and de Meuron's The De Young Museum in San Francisco, California.



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950.00
850.00
750.00
650.00
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450.00
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250.00
150.00
50.00



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Conclusion and perspective

From our experiments as well as the students work it seems fair to conclude that further research needs to be done in order to make the 'light-flow-meter' a quick and simple tool for the visual assessment of spatial and form-giving characters of daylight, i.e. to assess the shading pattern or shadow-types visually just by looking at the renderings of the spheres. Further research might look at the need for a 'calibration' of the renderings (possible involving HDR imaging) as well as more elaborated reference material to compare with.

However, the digital 'light-flow-meter' proved useful in assessing the direction(s) of daylight within a space and pointing out areas where light from different directions 'meet'. In that sense the 'light-flow-meter' served as an easy and quick tool for the assessment of the 'flow of light'.

For lighting architects and – designer it would be very useful to have a tool for the visual assessment of the form-giving characters of light and it would be even better if this tool was unambiguously 'readable' – like a meter. Frandsen's concept of the *scale of shadow* is geometrically defined, while Kit Cuttle's '*flow of light*' concept is numerically well-defined (in relation to the vector/scalar ratio). These concepts could serve as points of departure, but it might also be a matter of integrating *illuminance vectors* (as shown in Axel Jacobs RADIANCE Course (Advanced) from Feb. 2006) into a 'user-friendly' interfaces like Light Studio or Ecotect.

Finally, the Light Studio interface has some good and some bad points. It makes Radiance more accessible for people who model buildings with AutoCAD/ArchiCAD, but still the learning curve is quite steep. We still found that Radiance, even with this familiar interface, is not as user-friendly as other renderers... Integrating the long-term daysim style rendering into the interface is our next hope for improvement.