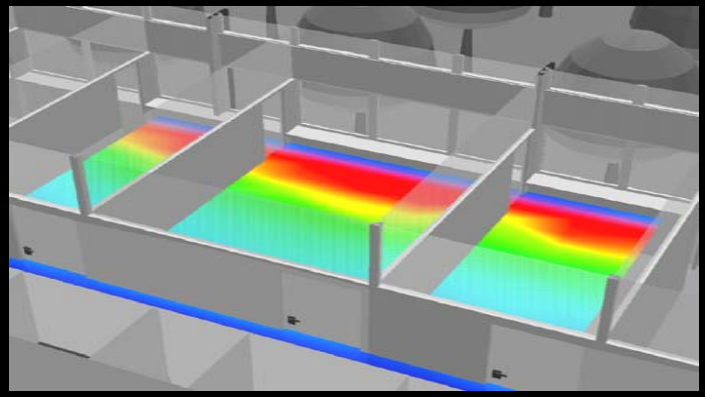
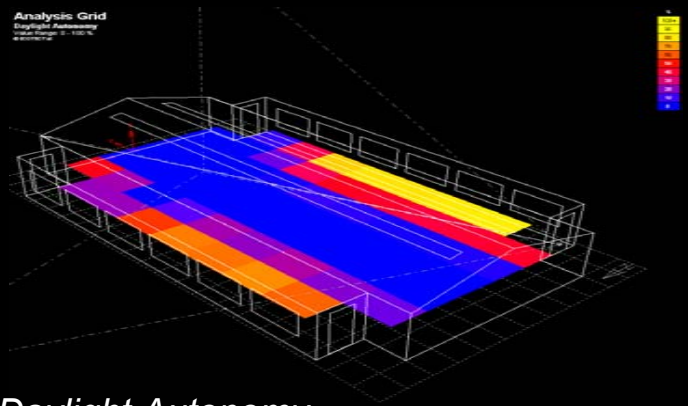
Natural Light in Design

Using simulation tools to explore realistic daylight-responsive solutions

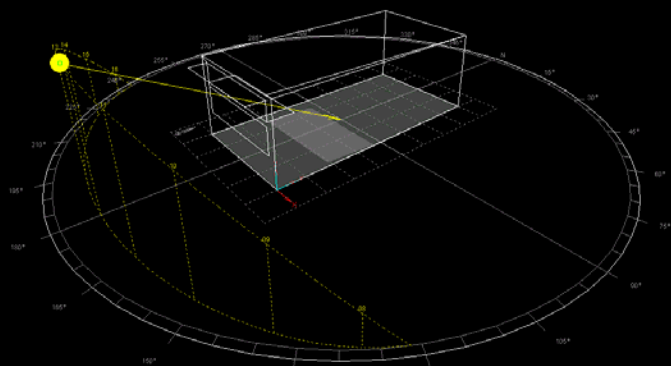


Daylight Factor

Visual Comfort



Daylight Autonomy



Avoidance of Direct Sunlight

Static Daylighting Metrics

Christoph Reinhart, Ph.D.

Overview – Static Daylighting Metrics

Tuesday, Jan 24th 2006

time slot	Content	instructor
Mon 9.30	Welcome, class introduction, design project (teams formed next morning)	MA, all
Mon 10.00	- General Introduction to daylighting (benefits, history, some case studies)	MA
Mon 10.30	- Introduction to Building Simulation (why simulations for architects, tools used in this course)	CR
Mon 11.00	coffee break	
Mon 11.15	- Photometry (definition, measurement, typical values, DF definition (MA)	MA, CR, all
	- Static Daylighting Metrics (context of LEED, selected results from NRC survey, DF & Solar Shading) (CR)	
	- Daylight factor calculations: protractor method, LEED spreadsheet method, sky models CIE and Perez (MA) - Daylight factor simulation: design sky, split flux method in Ecotect (CR) ▪ Hands-on exercise: DF calculation in Ecotect (split flux) (CR) ▪ Hands-on exercise: solar shading module in Ecotect (CR) - Intro to Radiance (CR) ▪ Hands-on exercise: Radiance visualizations (CR) ▪ Hands-on exercise: DF calculation in Ecotect (Radiance) (CR)	
Mon 13.00	lunch (on your own)	
Mon 14.00	- Climate Data (kind of data and measurement, weather files, E+ weather data directory) (MA) ▪ Hands-on exercise: weather tool in Ecotect (CR) - Overview on visual comfort (glare, contrast, requirements, health) (MA) - Dynamic Metrics & related tools (CR)	MA, CR, all
Mon 15.45	coffee break	
Mon 16.00	▪ Hands-on exercise: Daysim exercise from tutorial interrupted by discussions on: - Short time steps dynamics - Daylight Coefficients - User Behavior Model - Daylight Autonomy Results	all
Mon 17.00	▪ Hands-on exercise: students to repeat at DF, Solar Shading &DA analysis on their own	all
Mon 17.30	end of first day	

Objectives for this module

- Discuss daylighting design intentions
- Introduce some daylight performance metrics

What is good daylighting?

Context I

LEED and Green Globe provide daylight credits for:

- daylight factor
- view to the outside
- specification of shading devices (Green Globe only)

Compliance is verified via spreadsheet method.

Context II- What is Daylighting?

173 Design Practitioners (over 80% using LEED) choose

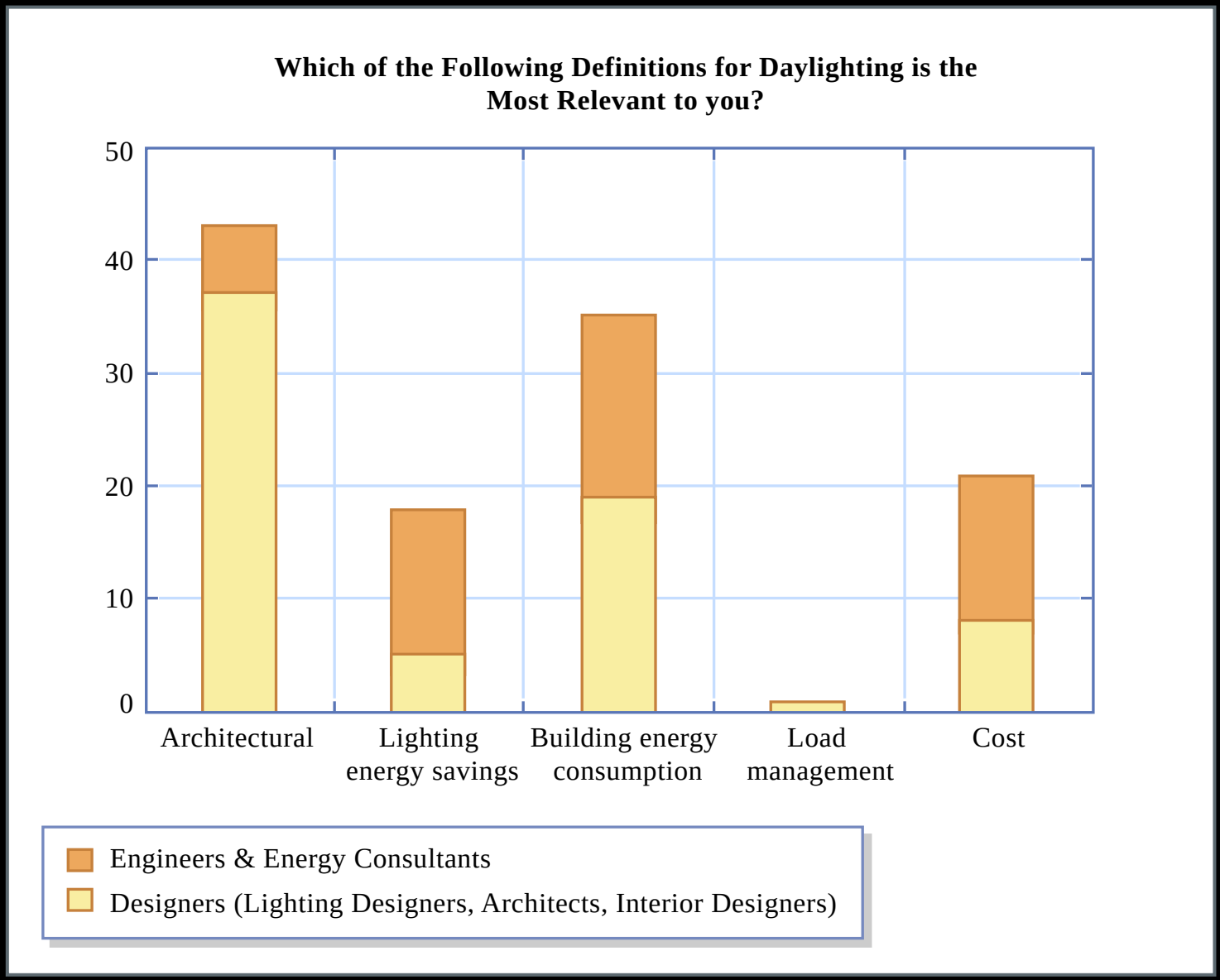


Figure by MIT OCW.

Context III- What is Daylighting?

**	***Architectural definition:*** **the interplay of natural light and building form to provide a visually stimulating, healthful, and productive interior environment**
	Lighting Energy Savings definition: **the replacement of indoor electric illumination needs by daylight, resulting in reduced annual energy consumption for lighting**
*	***Building Energy Consumption definition:*** **the use of fenestration systems and responsive electric lighting controls to reduce overall building energy requirements (heating, cooling, lighting)**
	Load Management definition: **dynamic control of fenestration and lighting to manage and control building peak electric demand and load shape**
	Cost definition: **the use of daylighting strategies to minimize operating costs and maximize output, sales, or productivity**

Do daylight factor & view LEED to good daylighting?

Daylight Factor Definition

$$DF = (E_{point}/E_{outside\ horizontal}) * 100\%$$

The DF is only defined under overcast skies!

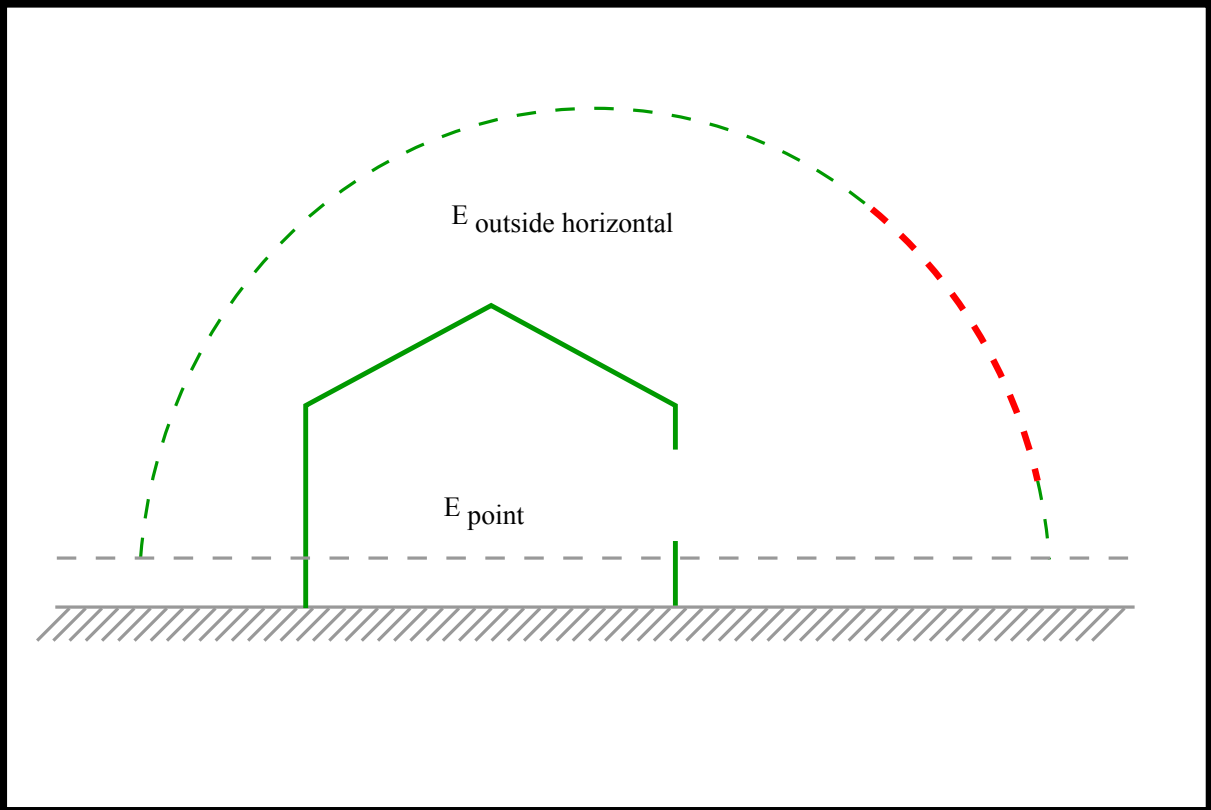
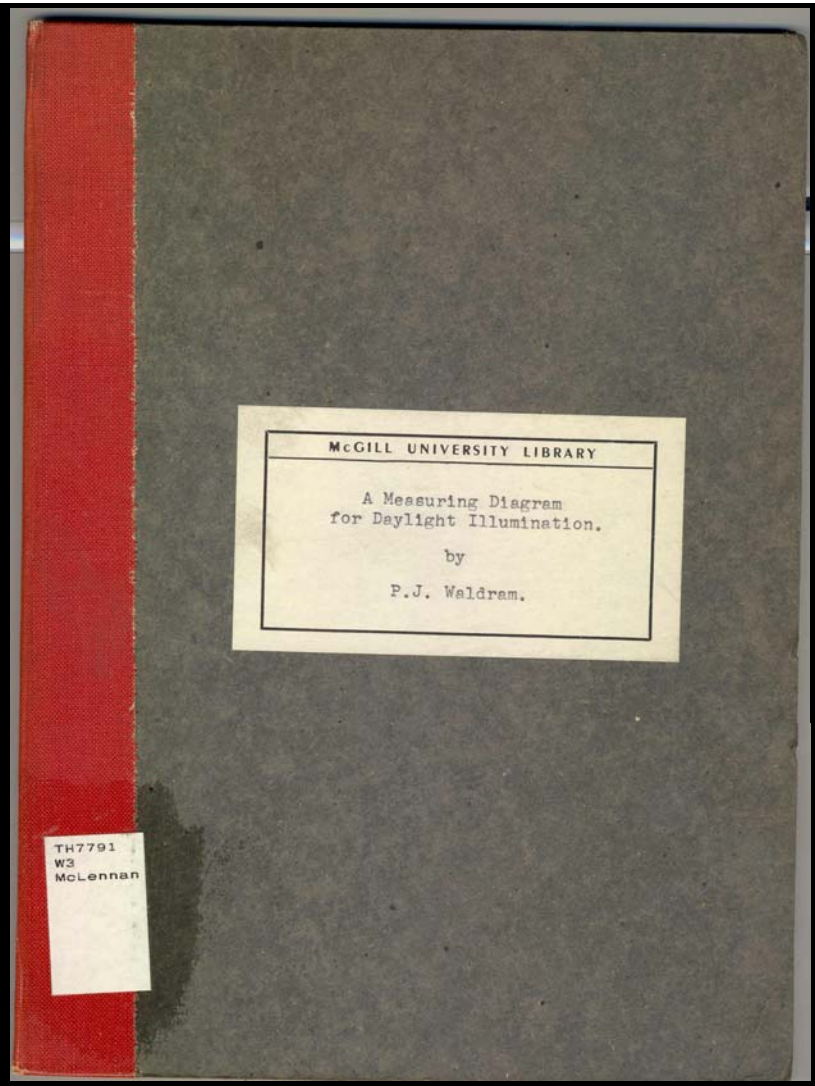


Figure by MIT OCW.

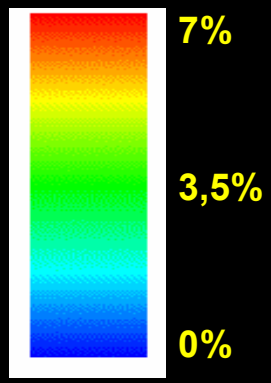
Historical Background: “Right of Light”

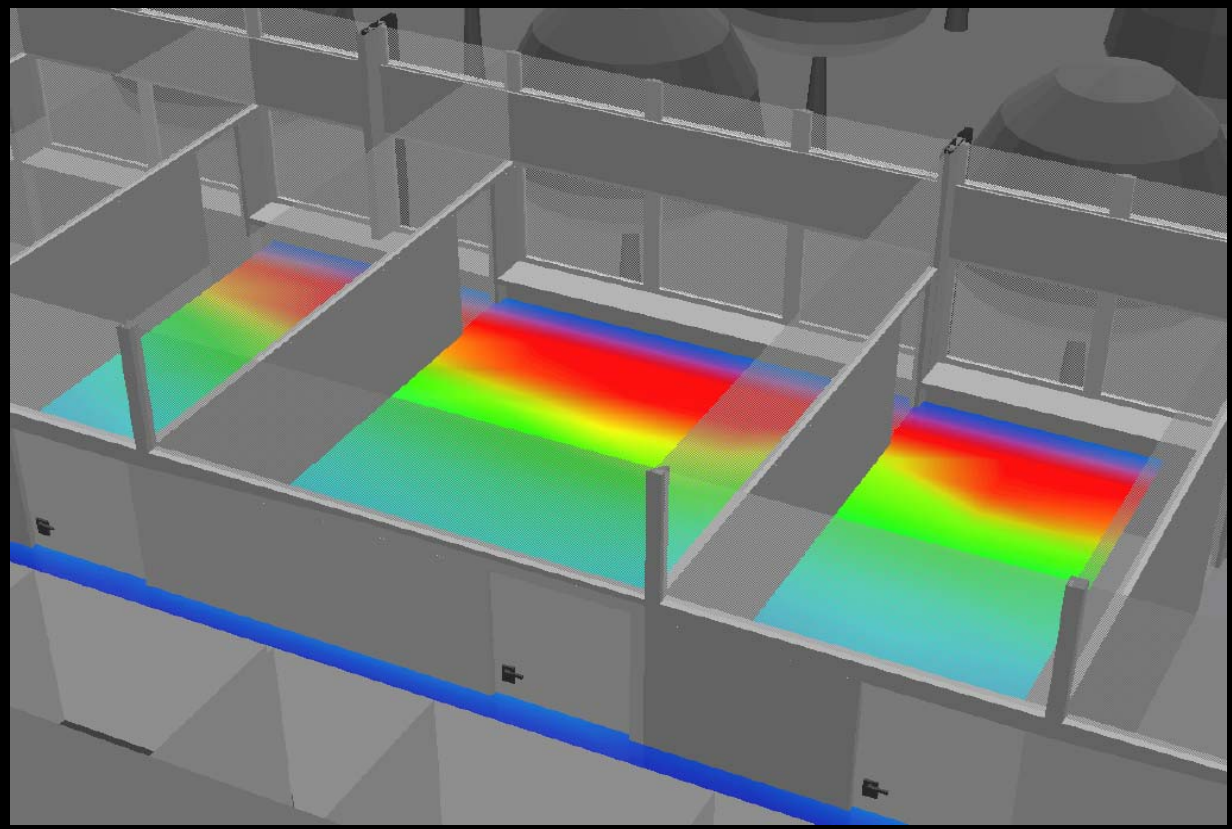
UK Prescription Act (1832): If one has benefited from daylight access across some else's property for over 20 years, an absolute and indefeasible ‘rights to light’ is granted to the building.



Waldram 1945

Daylight Factor Use in Design



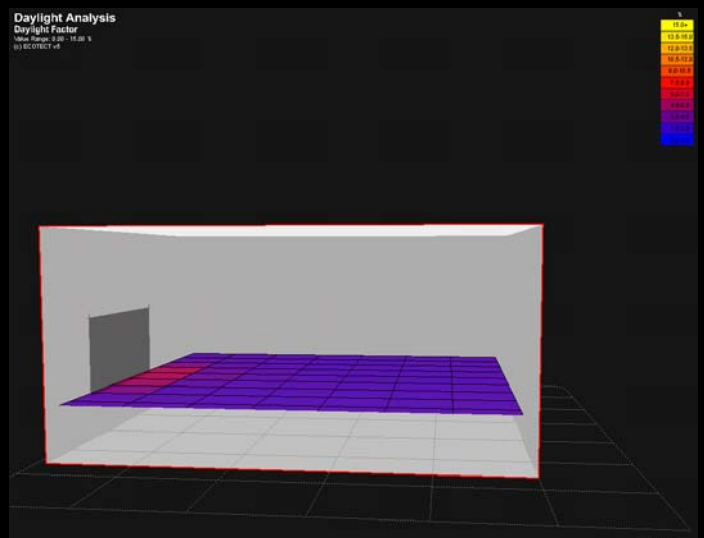


Pro:

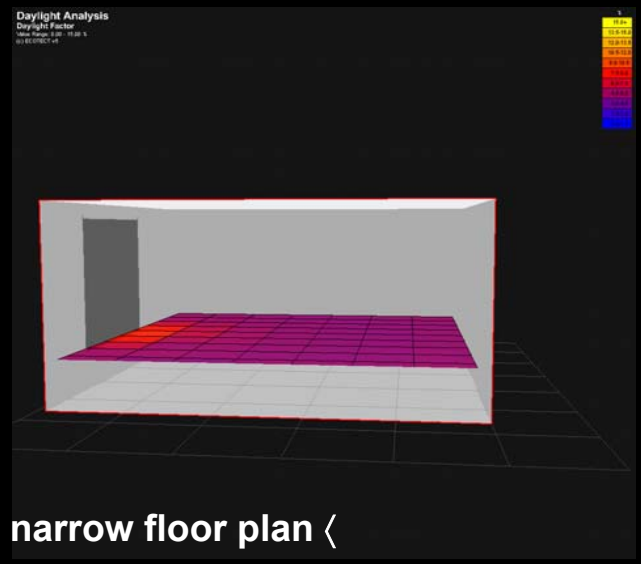
- ❑ intuitive quantity
- ❑ overcast sky as a worst case scenario
- ❑ venetian blinds (even if closed) still admit sufficient DL

Daylight Factor – design implications I

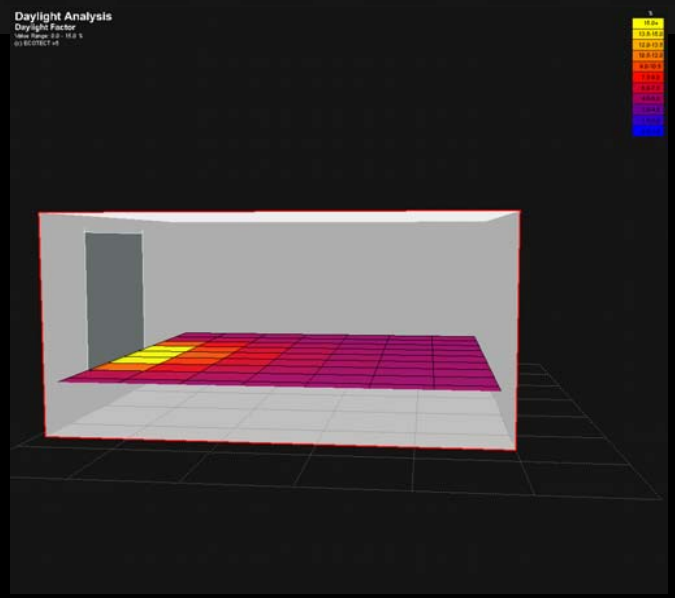
reference



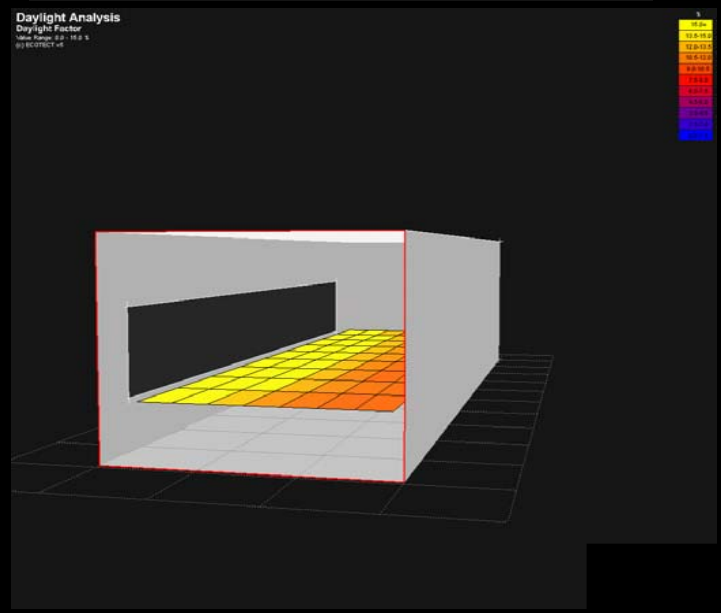
window head height ⟨



glazing type ⟨

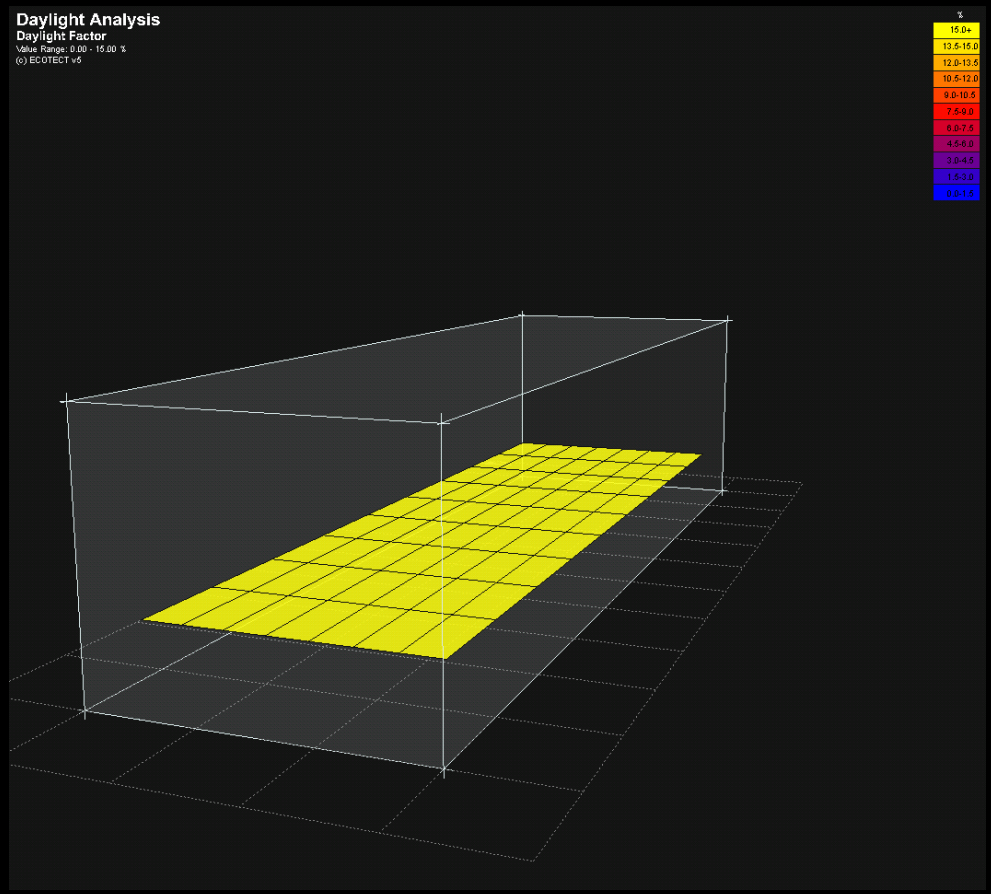


narrow floor plan ⟨



Daylight Factor – design implications II

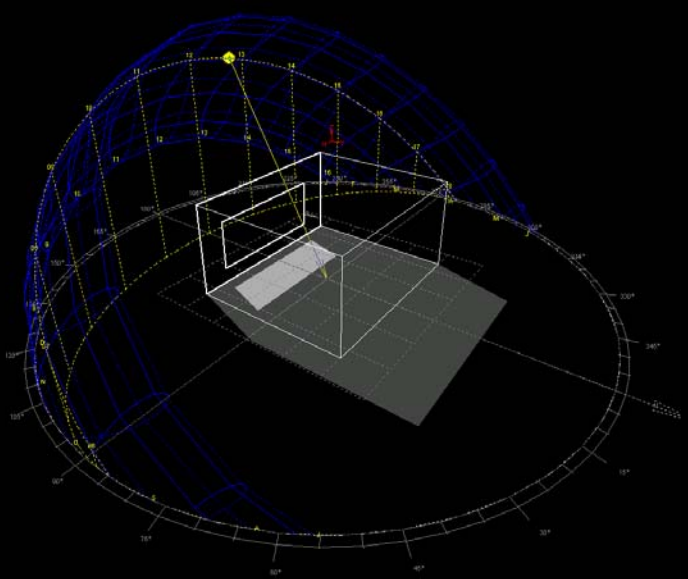
The daylight factor optimized building is fully glazed.

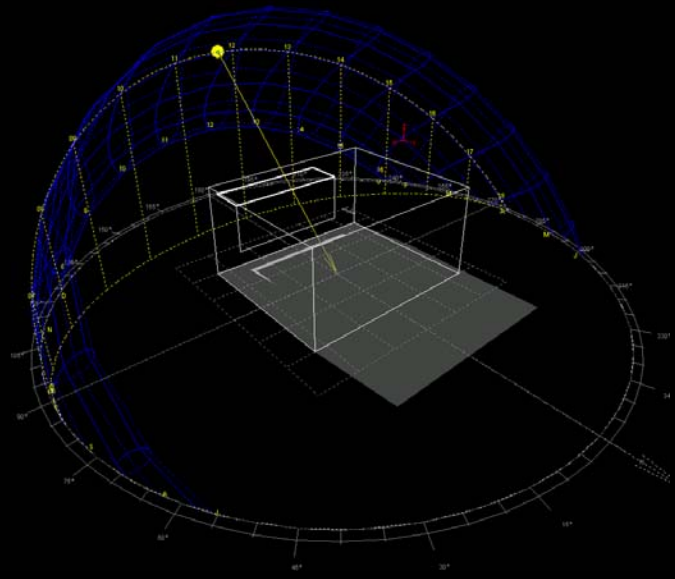


Note, there are LEED certified buildings that are fully glazed!

Avoidance of Direct Sunlight

optimized for static shading device
louvers, lightshelves etc.〈





Resulting building design form good from an energy standpoint.