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DAYLIGHT DESIGN	採光設計
(daylighting systems for windows)	窓のデイレティングシステム
Overview	概要



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採光設計
Daylight design

Problem
問題



Discipline
分野

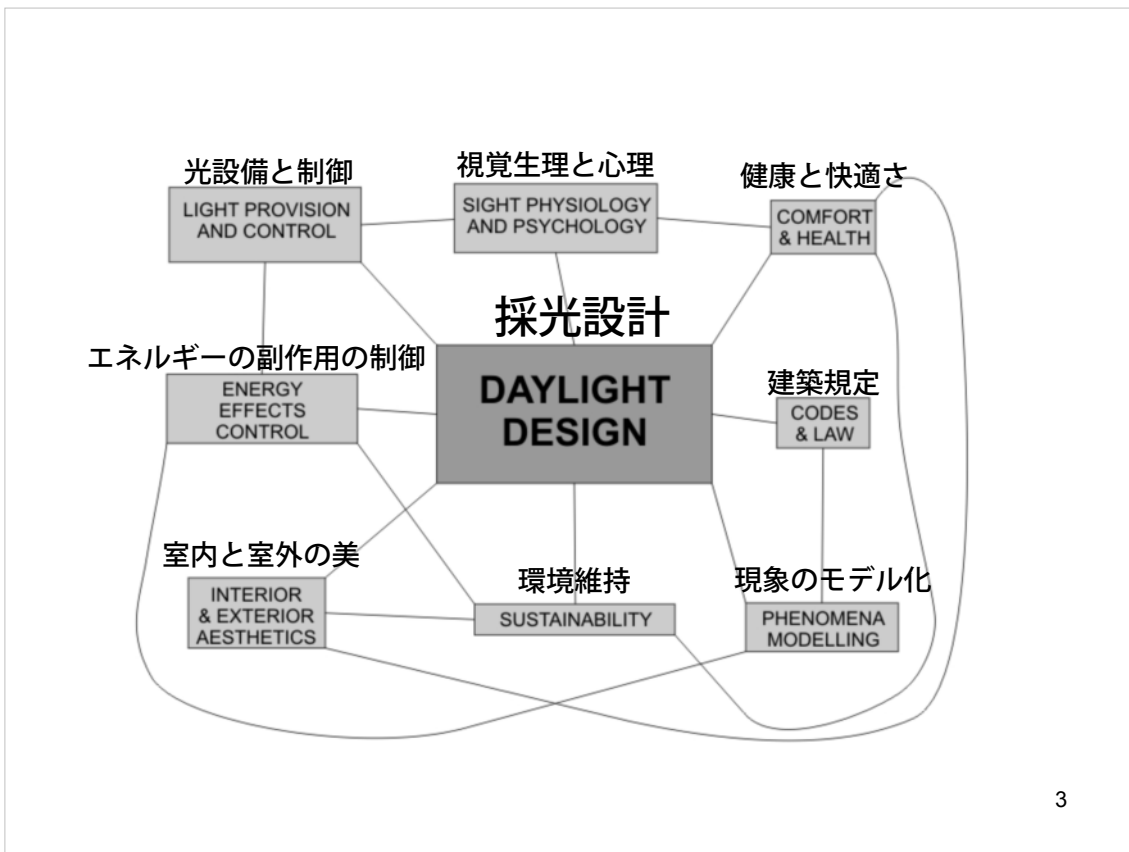
Provision and distribution of available daylight to the interiors in order to create comfortable environment.

Part of Sustainable Architecture (multidisciplinary problem)

快適な環境を作るために利用可能な光を室内に分配すること

環境維持建築

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Country	Building codes	Standards, norms
Belgium		NBN L 13-002: Daylighting of buildings. Determination of natural illuminance under overcast sky conditions. (Consisting mainly of a translation of the CIE publication: No 16, 1970)
Denmark	Danish Building Code 1995	Ministry of Labor, Order No 1163, 1992 (Window area \approx 10% of floor area by sidelight, or 7% by toplight)
France	Code du Travail (Work Code) Code de la Construction et de l'Habitation (Building and Housing Code) Code de l'Urbanisme (City Planning Code)	NF X 35-103: Ergonomical principles applicable to the lighting of workplaces for visual comfort NF X 35-121: Work on visual display unit and keyboard - Fittings of the work premises and the workplace
Germany	Landesbauordnungen (State Building Codes); each German state has one of its own Verordnung Über Arbeitsstätten / Arbeitsstättenrichtlinien (Workplace Regulations), Nation-wide Tageslicht in Innenräumen, DIN 5034, Deutsches Institut für Normung e.V. (Daylighting in Interiors, DIN 5034, German Industrial Standards) - General Standards. Considering daylighting, the building codes and workplace regulations refer to this Standard. Consists altogether of 6 parts nowadays.	General requirements: Definition of terms / psychological importance of windows / Indoor illumination with daylight / Direct sunlight and sun protection Principles: Definition of terms / Astronomical basics / Radiation basics / Calculations: Daylight factor / Sunshine duration / Occupation time Simplified determination of minimum window sizes for dwellings Measurements: Definition of quantities to measure / Measurement equipment / Preparation of measurements / Simplified determination of suitable dimensions for roof lights
Greece	Greek Building Regulations (Ministry Decision 3046/304/30, 1/3.2.1989, Government Official Gazette 59)	All spaces for primary use have to be provided with an aperture to the exterior of a min. size of 10% of the floor area The main staircase of building has to have natural lighting
Ireland	1991 Building Regulations, T. G. Part 1: Conservation of fuel & energy (government regulations)	Energy Efficient Lighting, Eolas (The Irish Science and Technology Agency) BS.8206-part 2 code of practice for daylighting Site Layout Planning for Daylight and Sunlight - BRE PJ Littlefair
Italy	Ministry Decree 05/07/75 for dwellings: glazed area min. 12.5% of floor area; mean value of $df \geq 2\%$ Ministry Decree 18/12/75 for schools: schoolrooms and laboratories $df = 3\%$; gymnasia $df = 2\%$; corridors, stairs and bathrooms $df = 1\%$	Memorandum No 71911/10.0.296, guidelines for VDU, Feb 1991 Legislative Decree No 626, Sept 1994

建築規定 Legislation

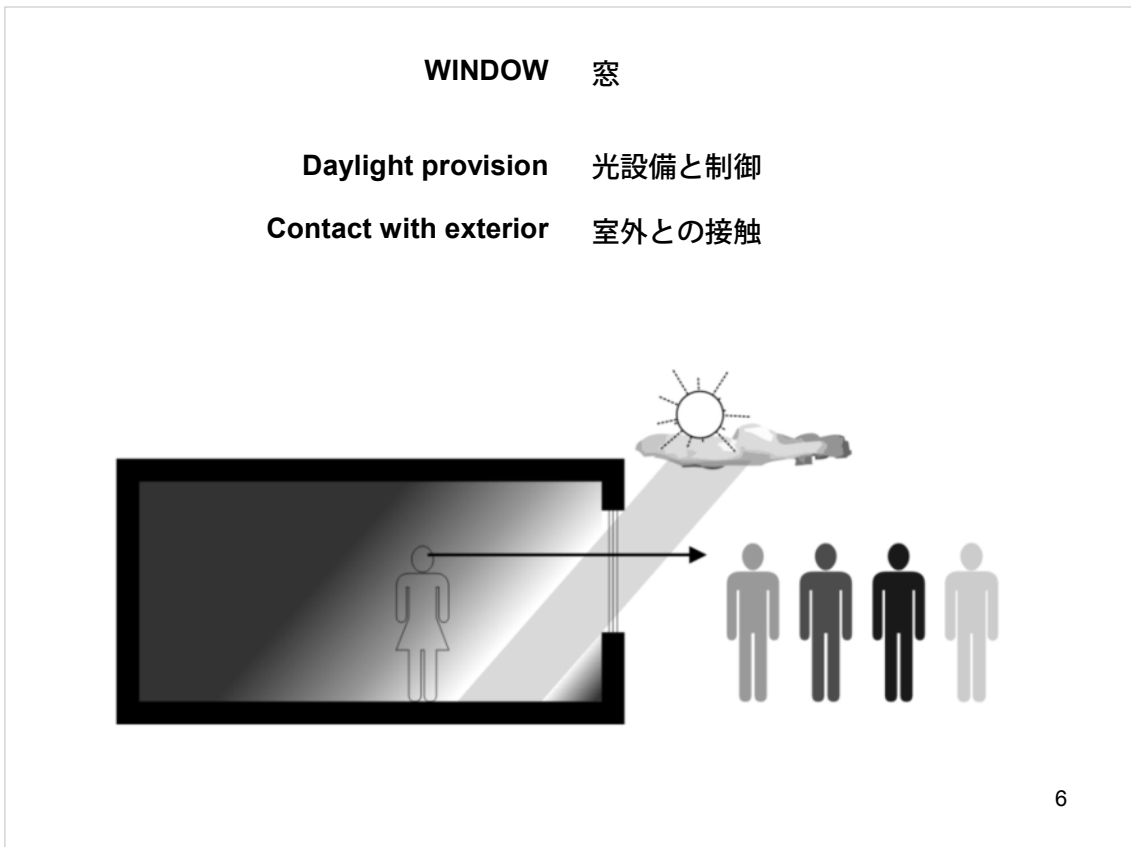
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Norway	Tekniske forskrifter til plan og bygningsloven, 1997 Access to daylight mandatory for dwellings and workplaces Min. 1% df halfway into room, 1m from side wall, 0.8m above floor Glazed area min. 10%	Löfberg: Räkna med dagsljus Swedish Standard SS 914201: Dagsljus – Förenklad metod för kontroll av erforderlig fönsterglasarea
Portugal	General Regulation on Urban Buildings, 1951 (Decree-Law No 38382)	Technical Norms for the Design of Residential Buildings, Lisbon, LNEC, 1994 (Section 6.3.5: Visual Comfort)
Spain	Daylight building code rules in Spain are quite old. Usually they are only related to fenestration surface as a minimum (12.5% of the floor surface for living spaces)	
Sweden	There are no strict building codes, they just say 'adequate daylight' for dwellings (code issued by Boverket) The code recommends a glass area of min. 10% of floor area. With more than 20° horizon screening the glass area is recommended to be increased according to SS914201	SS914201: Dagsljus – Förenklad metod för kontroll av erforderlig fönsterglasarea Löfberg: Räkna med dagsljus Recommendation: The earlier building code stated 'at least 1% daylight 1m from side wall, at table high (0.8m above floor), halfway from windows to inner wall'. This is still regarded as reasonable goal even it is no longer clearly expressed in the new code. The value is for dwellings, but has also been used for offices, schools, nurseries etc.
Switzerland	Federal law for working spaces (10% minimal glazed ratio, 1/16 external view) Cantonal and district specific laws	ASE 8911.1989: Indoor illumination by the way of daylighting SIA 3804: Electrical installation within buildings
United Kingdom	For ventilation purposes the opening area of windows should be 1/20 the floor area	BSS206 Part 2: Code of practice for daylighting Site layout planning for daylight and sunlight

Poland:
PN-71/02380 pt. „Oświetlenie wnętrz światłem dziennym”
PN- EN 12464-1: 2004 pt. „Światło i oświetlenie / Oświetlenie miejsca pracy / Cz. 1 Miejsca pracy w wnętrzach”
EN- 12665: 2003 (U) pt. „Światło i oświetlenie- podstawowe terminy oraz kryteria określania wymagań dotyczących oświetlenia.

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建築規定 *Legislation*

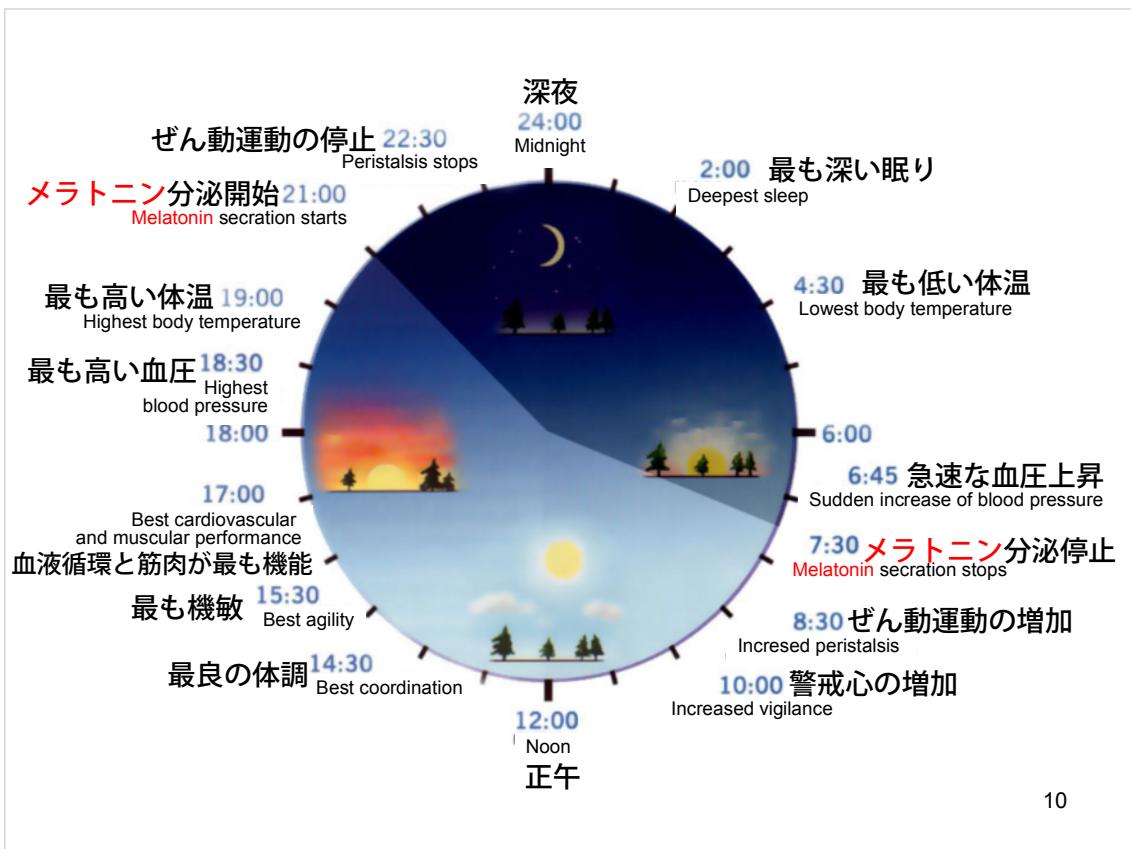
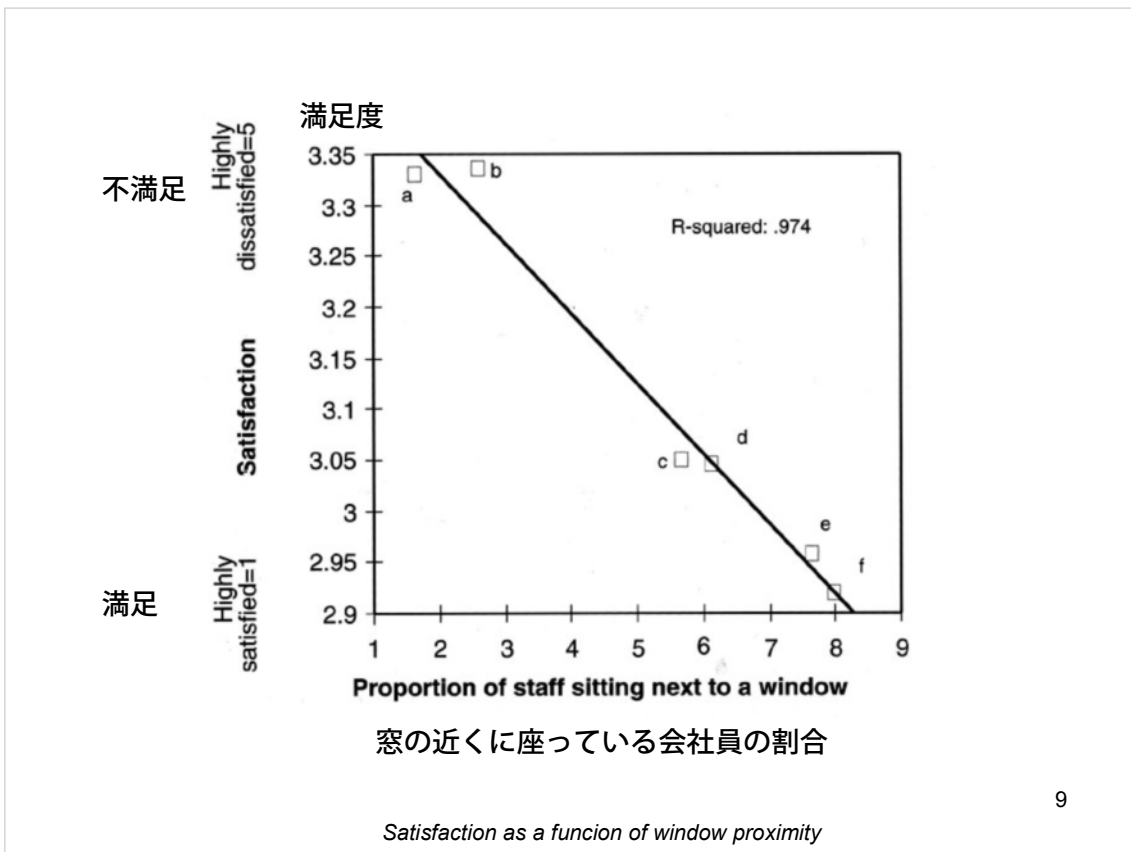


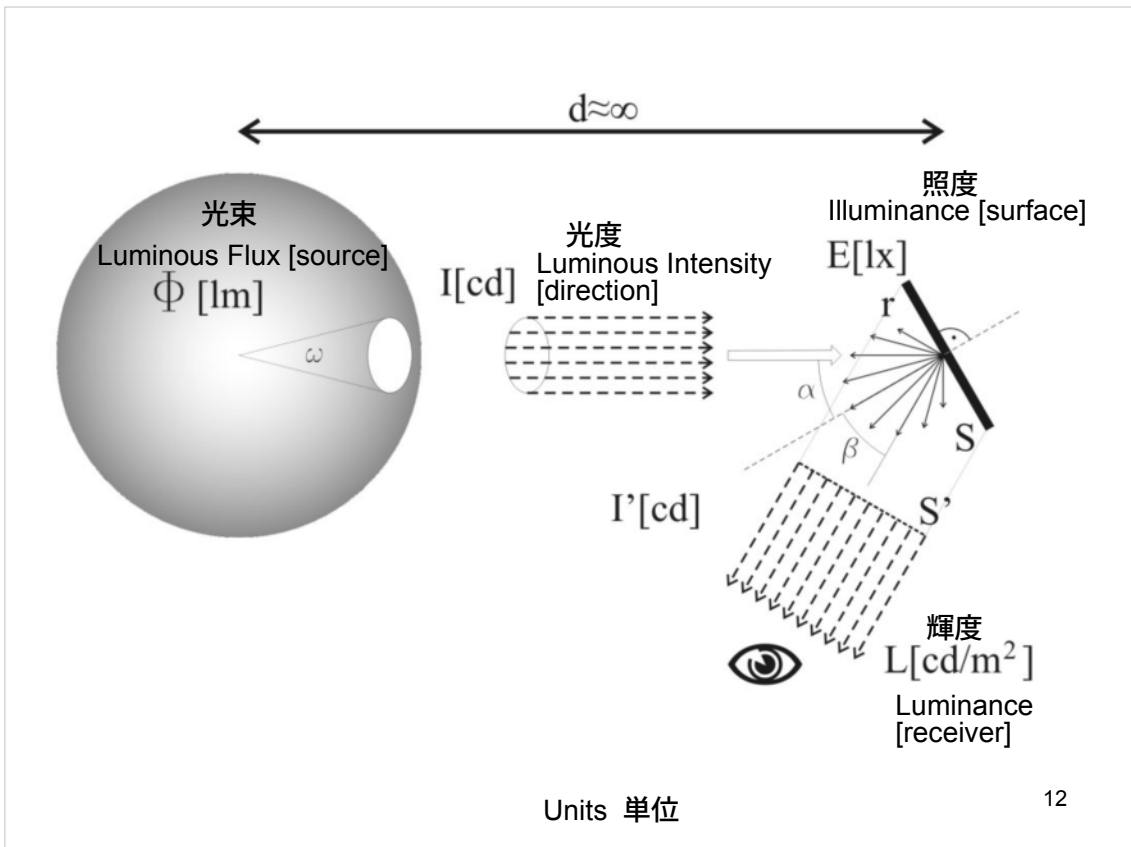
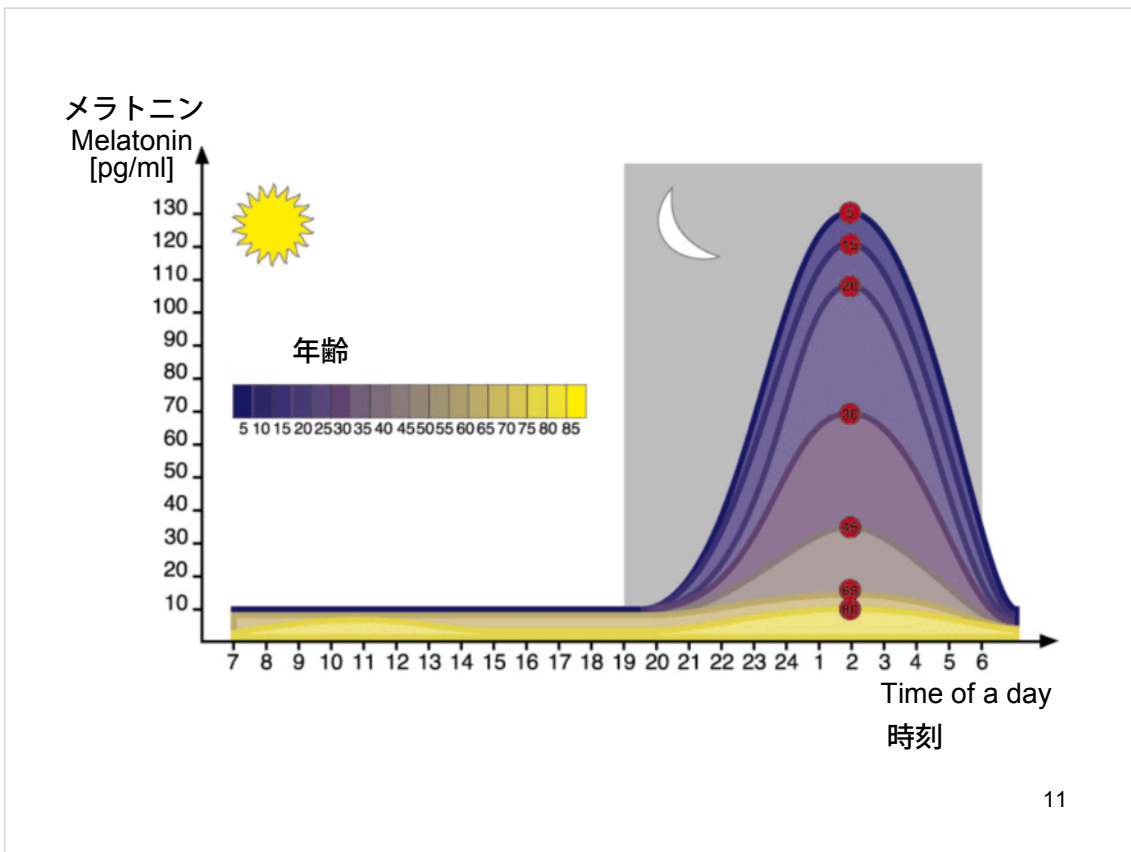


WINDOW is likely to remain the most common way of providing visual contact with the exterior

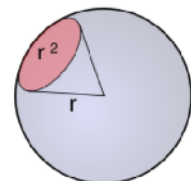
室外との接触







steradian ステラジアン



$$\Omega = \frac{S}{r^2}$$

where
S is the surface area, and
r is the radius of the sphere.

I Luminous intensity 光度

Luminous intensity is a measure of the wavelength-weighted power emitted by a light source in a particular direction, based on the luminosity function, a standardized model of the sensitivity of the human eye

$$I = \frac{\Phi}{\omega}$$

candela カンデラ

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.

E Illuminance 照度

illuminance is the total luminous flux incident on a surface, per unit area.

$$E = \frac{I}{d^2} \cos \alpha$$

lux ルクス

measure of the intensity of light, with wavelengths weighted according to the luminosity function, a standardized model of human brightness perception. The difference between the lux and the lumen is that the lux takes into account the area over which the luminous flux is spread. 1000 lumens, concentrated into an area of one square metre, lights up that square metre with an illuminance of 1000 lux. The same 1000 lumens, spread out over ten square metres, produces a dimmer illuminance of only 100 lux.

L Luminance 輝度

Luminance is often used to characterize emission or reflection from flat, diffuse surfaces. Luminance is an indicator of how bright the surface will appear.

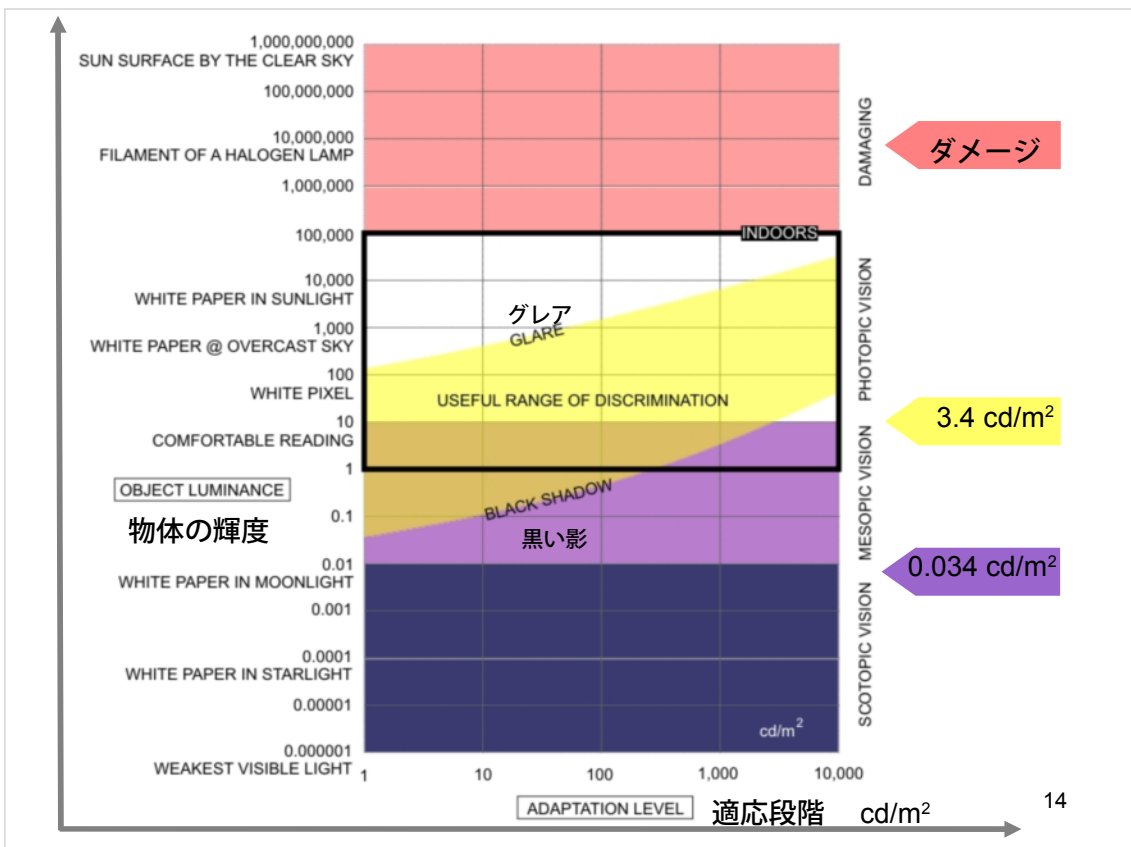
$$L = \frac{I'}{S'}$$

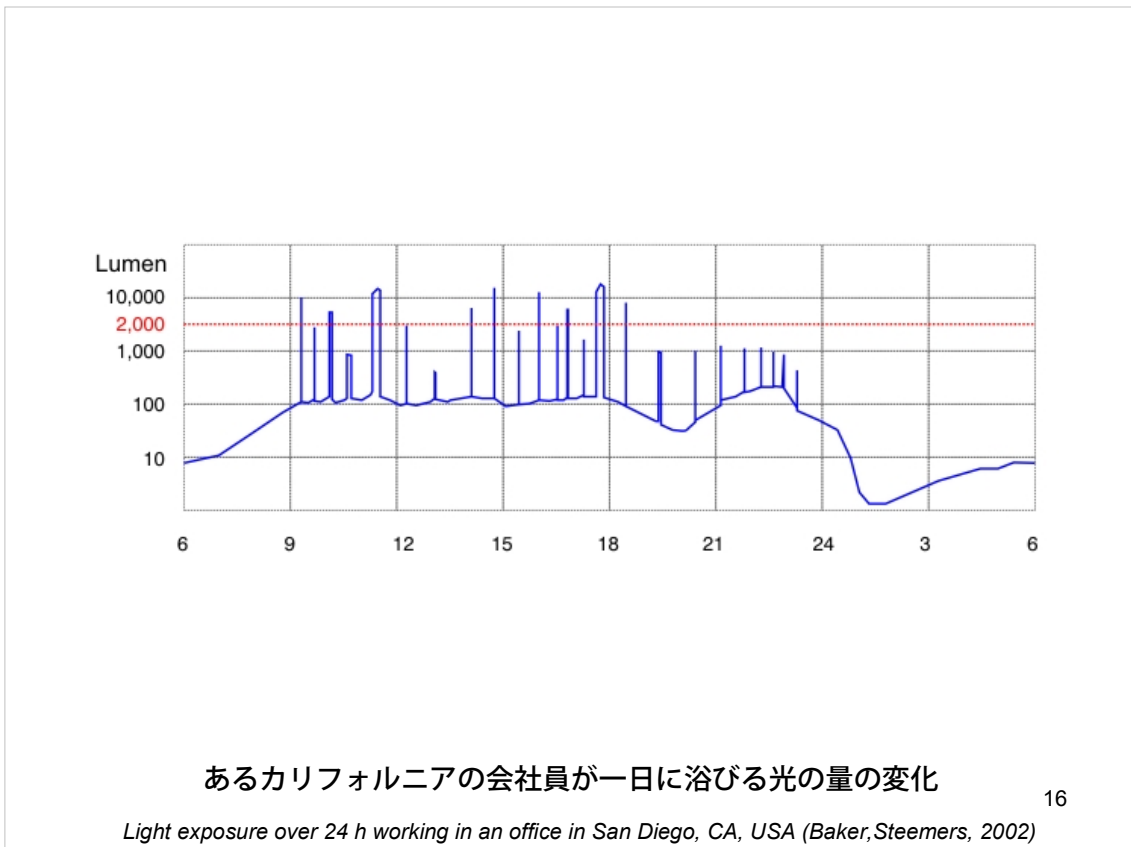
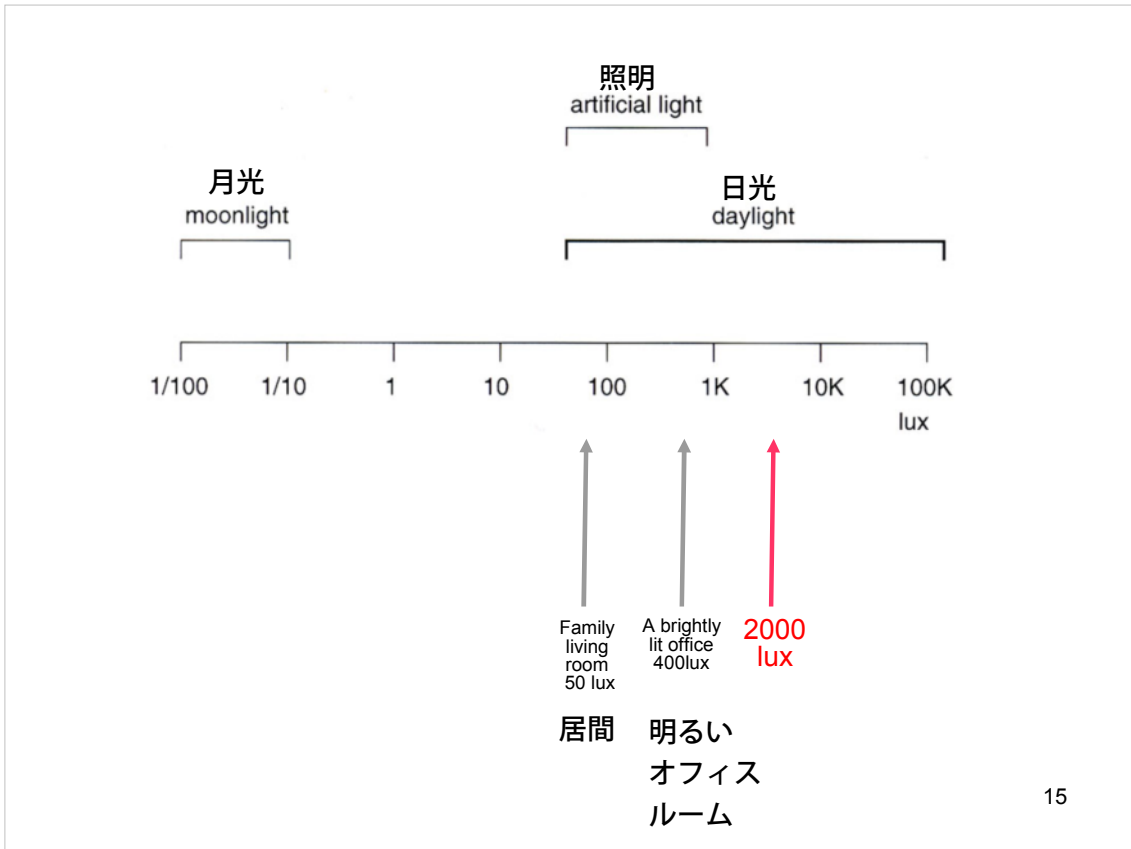
$S' = S \cos \beta$

lumen ルーメン

If a light source emits one candela of luminous intensity uniformly across a solid angle of one steradian, its total luminous flux emitted into that angle is one lumen. Alternatively, an isotropic one-candela light source emits a total luminous flux of exactly 4π lumens. The lumen can be thought of casually as a measure of the total "amount" of visible light in some defined beam or angle, or emitted from some source.

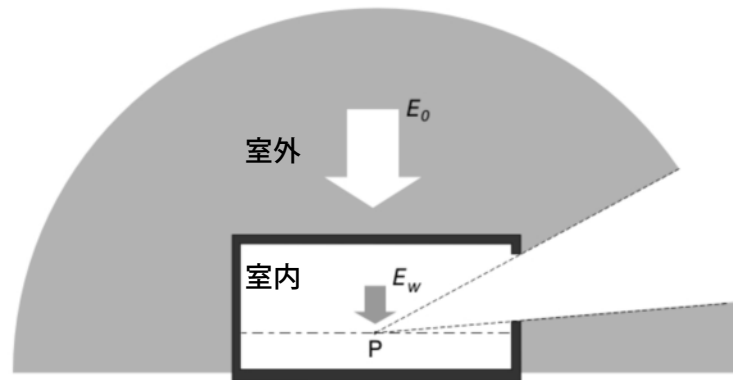
Lux is a derived unit based on lumen, and lumen is a derived unit based on candela.





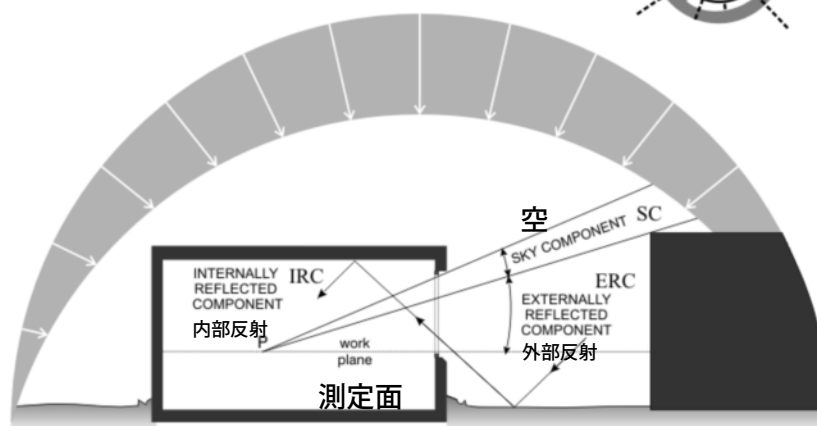
DAYLIGHT FACTOR **DL** 採光率

$$DL(P) = E_w/E_0 \times 100\%$$



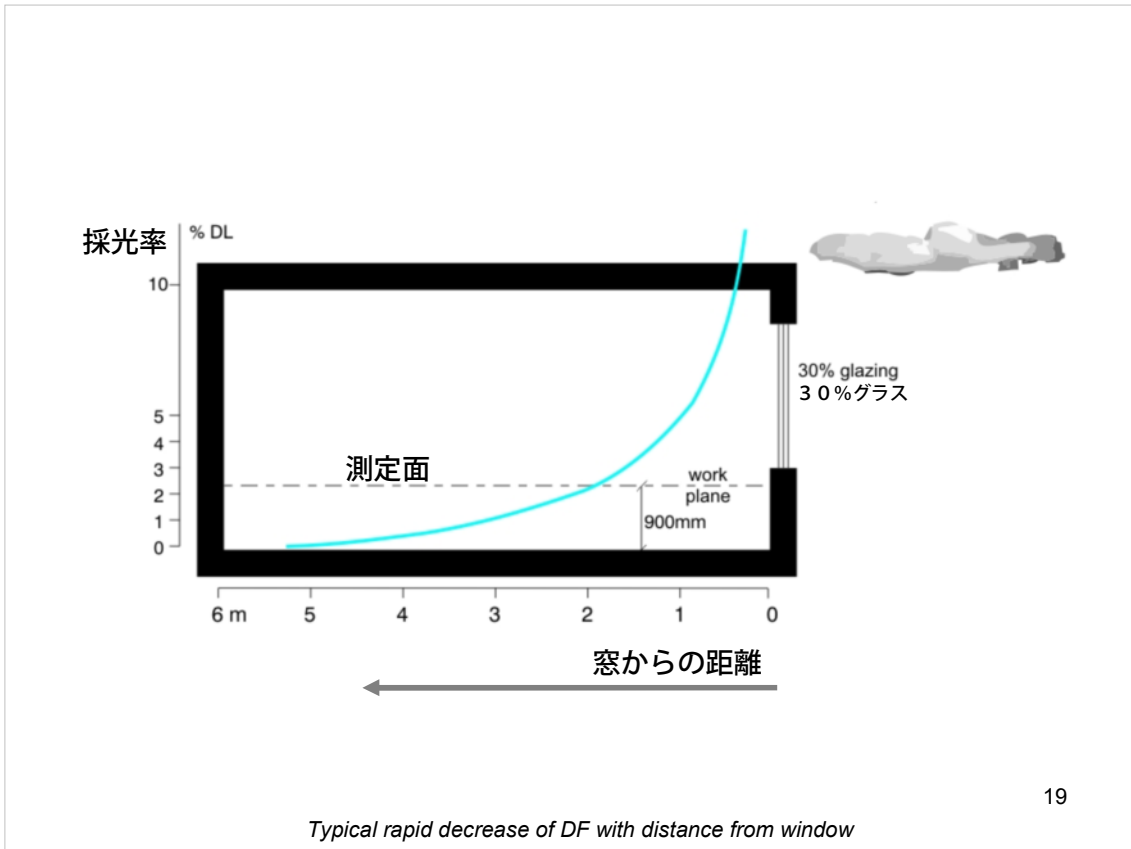
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直射日光がない

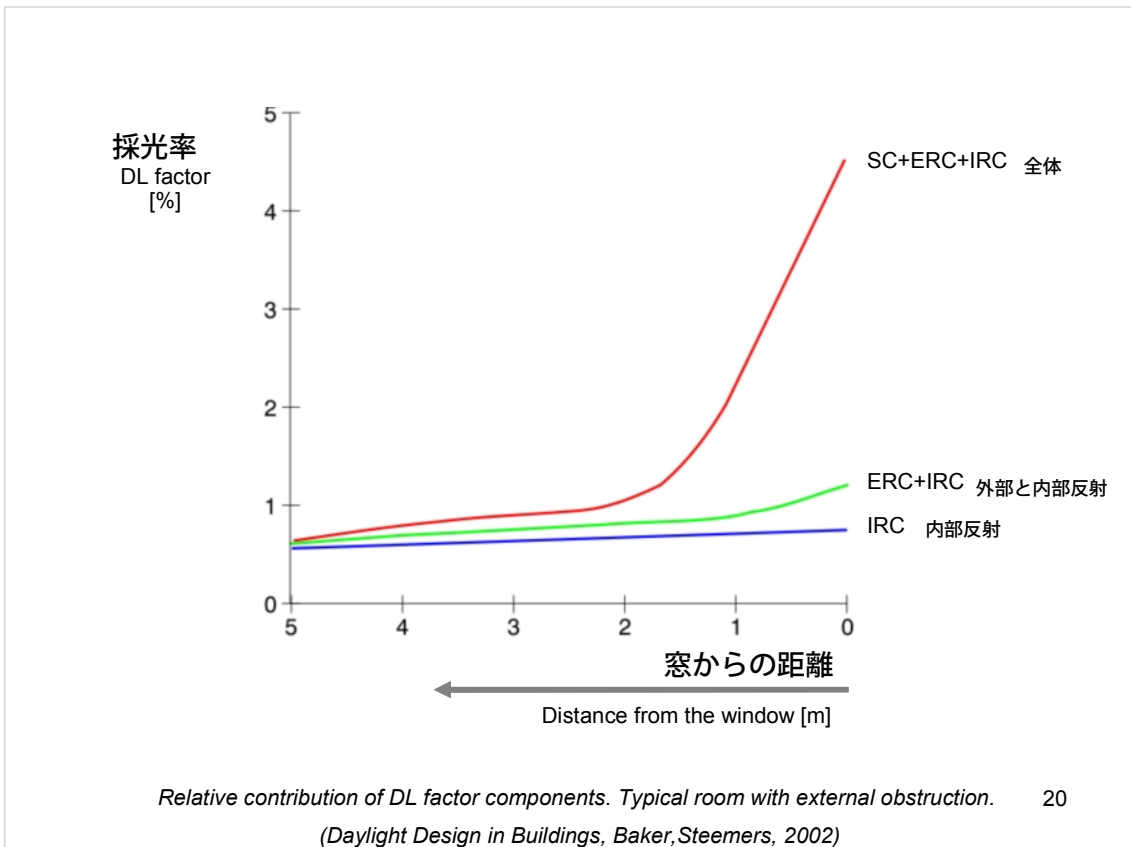


$$DL = SC + ERC + IRC$$

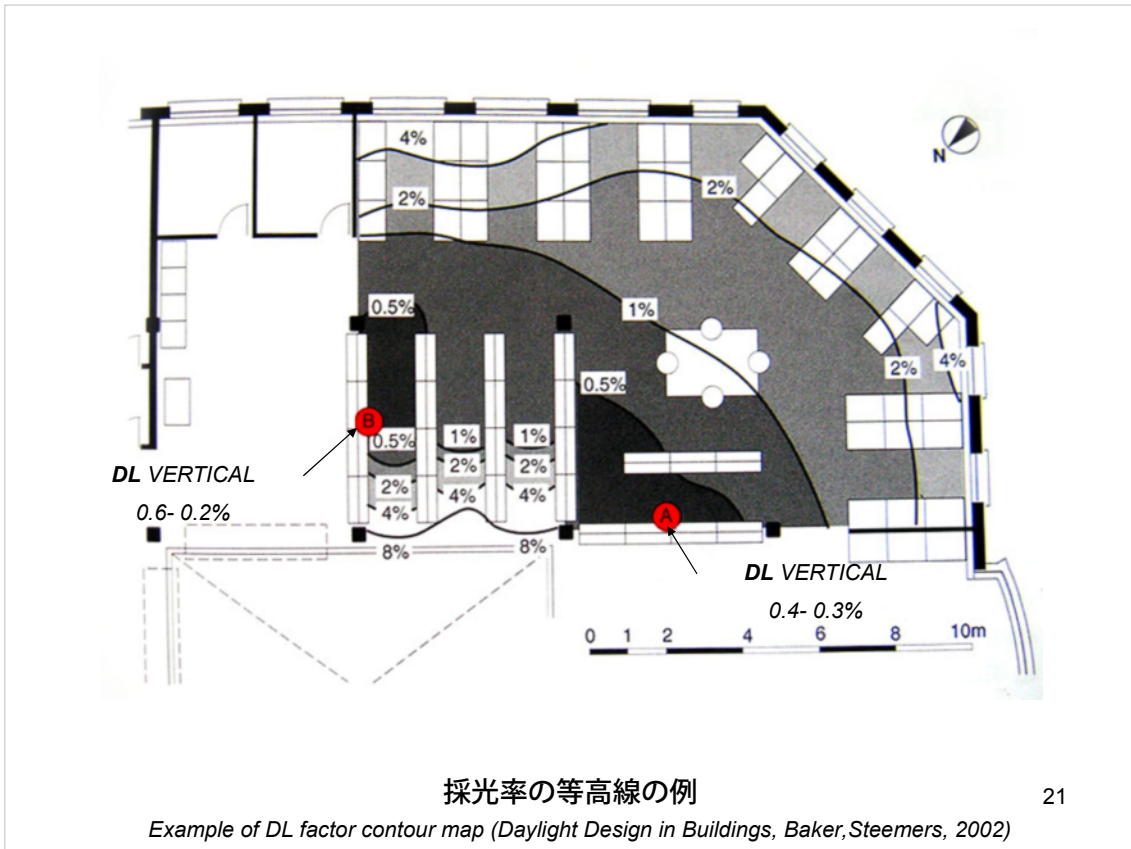
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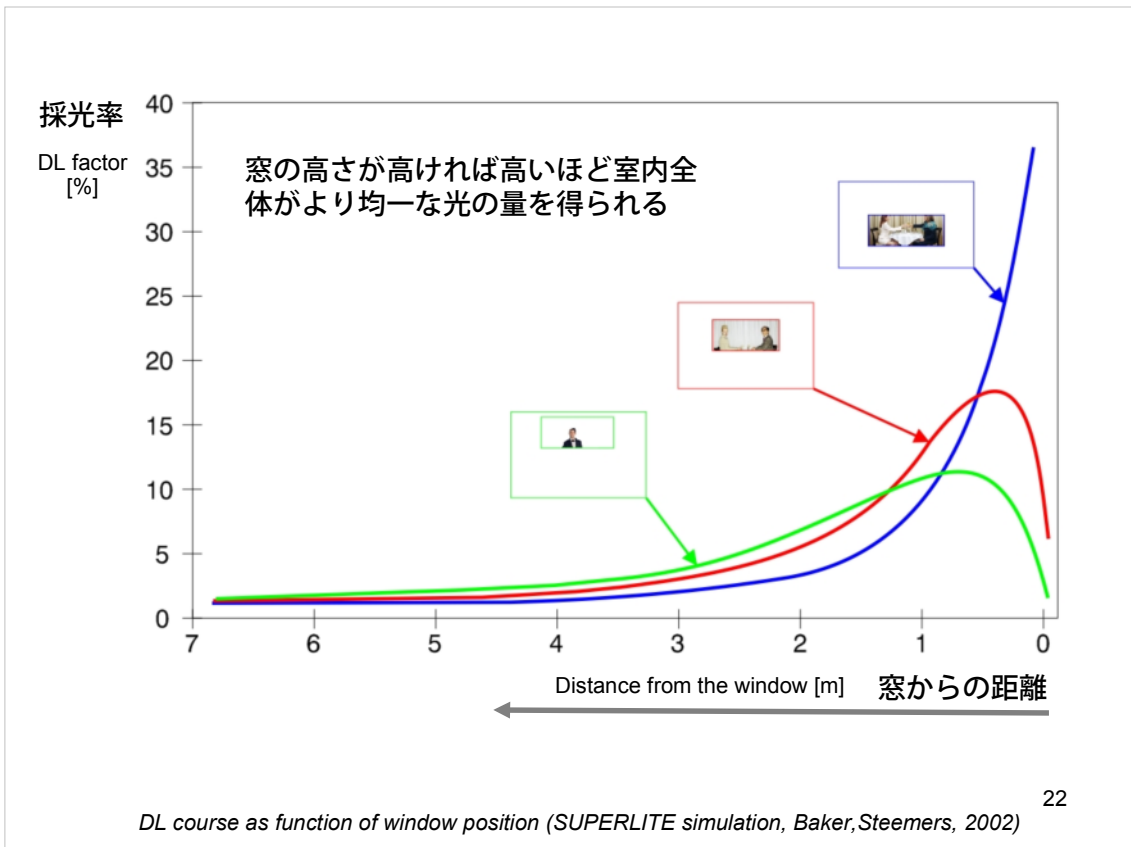
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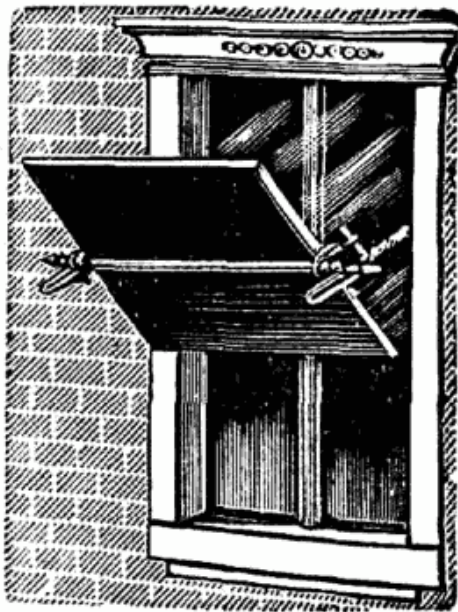


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Aesthetics: Facade 室外の美



External Lightshelf 室外光の棚



External semi-reflective light shelf
in a downward-tilted position

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Aesthetics: Facade 室外の美



Prismatic Panels プリズムパネル



アニドリック天井システムの開口部が導入された外壁
Facade with anidolic ceilings apertures. LESO, Lausanne (IEA, 2000)

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Aesthetics: Facade 室内の美



Light shelves 光の棚

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DAYLIGHT PROBLEMS

採光設計の問題

Large external obstruction

大きな外部の障害物

Too deep space to give adequate illuminance uniformity with conventional windows

横長すぎる部屋は採光量を均一にするのが難しい

Direct sun causing excessive contrasts in illumination (and glare)

直射日光によるグレア

Special lighting requirements (museums, offices...)

特別な光の需要 (美術館、会社ビル)

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DAYLIGHT PROBLEMS 採光設計の問題	ADEQUATE ACTION 適切な対策
Large external obstruction 大きな外部の障害物	Collection of incoming light from unobstructed areas of the sky and redirecting it inside the rooms 障害物のない所の空から入ってくる光を集め、室内に反射させる。
Too deep space to give adequate illuminance uniformity with conventional windows 横長すぎる部屋は採光量を均一にするのが難しい	Redirecting part of the incoming light flux toward the zones located furthest from the opening 部屋の明るい部分から暗い部分まで日光を送る。
Direct sun causing excessive contrasts in illumination (and glare) 直射日光によるグレア	Limiting direct sunlight penetration and redirecting it deep into the building (and scattering) 直射日光を制御し、室内に散乱させる。
Special lighting requirements (museums, offices...) 特別な光の需要 (美術館、会社ビル)	Reduction of glare and exclusion of direct sunlight penetration グレアの制御と、直射日光を防ぐ。