Fachgebiet
Lichttechnik

PhD topic

Idea to calculate luminous flux and directionality - Using RADIANCE?

source: se`lux

Developing criteria for categorisation of illumination quality in interiors

PhD topic

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Idea to calculate luminous flux and directionality - Using RADIANCE?

source: se`lux

Motivation:
Lighting quality in indoor workspaces

Lighting criteria in office environment (quantitative & qualitative)

- Luminance distribution
- Illuminance level
- Glare
- Directionality, direction of light
- Colour and colour rendering
- Flicker
- Daylight
- Variation (level and light colour)

(translated by author)

Motivation:
prEN 12464-1:2009 Directionality & Illumination quality

4.6.3 Modelling

Modelling ist die Ausgewogenheit zwischen diffusem und gerichtetem Licht. Es ist ein wesentliches Kriterium der Beleuchtungsqualität für praktisch alle Innenräume. Das allgemeine Erscheinungsbild eines Innenraumes verbessert sich, wenn seine baulichen Merkmale, die Menschen sowie die Gegenstände darin so beleuchtet werden, dass Form und Struktur deutlich und gefällig gezeigt werden. Dies wird erreicht, wenn das Licht vorwiegend aus einer Richtung kommt; die für ein gutes Modelling so wichtigen Schatten sollten dann eindeutig ausfallen.

Modelling means the balance of directed and diffuse illumination. It is an **essantial criterion for the quality of illumination of interiors**. The appearance of room increases by illuminating space, humans and solids with emphasizing contours and structure pleasantly. This can be realised, **when lighting incidents from one main direction**, so the important shadows for a good modelling appear distinctly.

(translated by author)

Research questions

Directionality and the incident direction of light

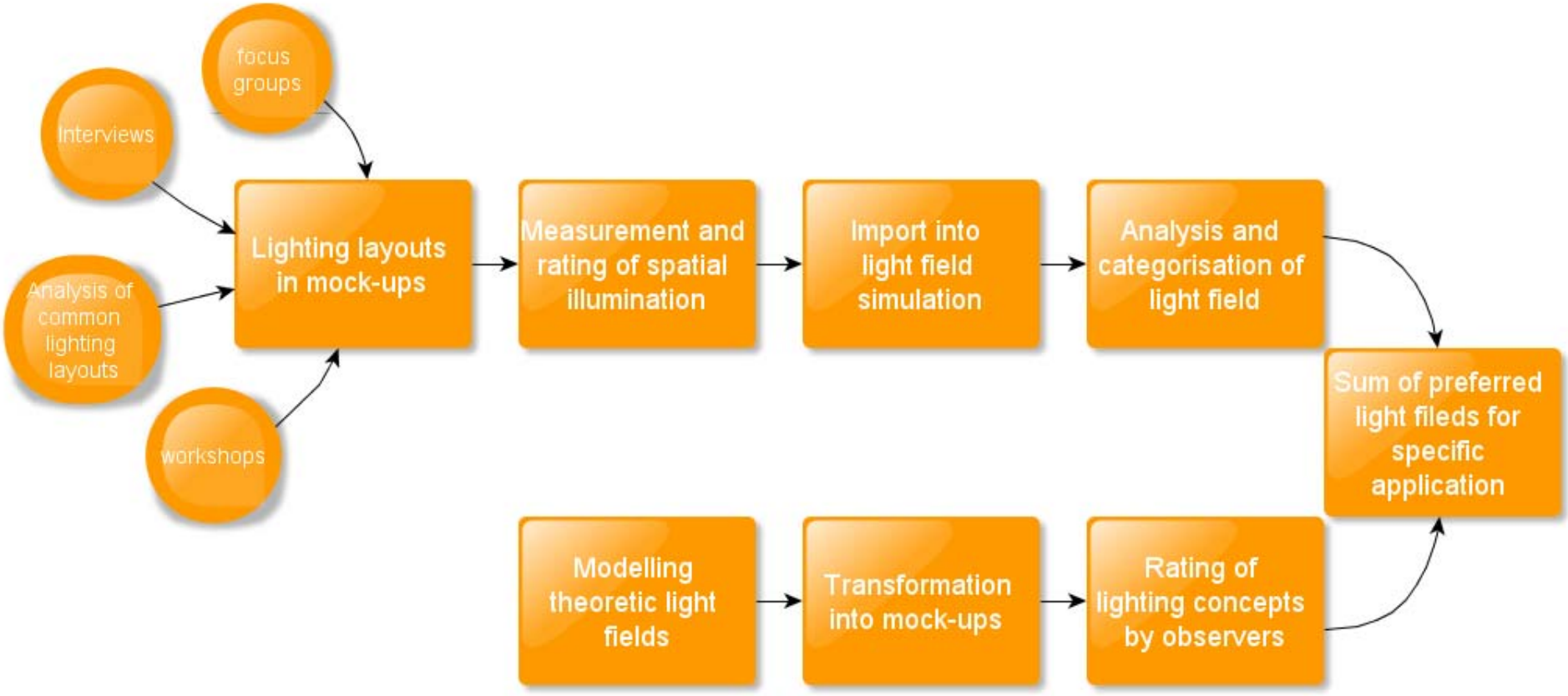
– How to describe scientifically?

– Do preferred situations exist?

– How to visualize these indicators for application in lighting design?

– What could be a suitable simulation tool?

Sketch: Evaluation of the light field theory



Digression: Light field theory

Selection of authors & ideas

- Michael Faraday, 1846

  lecture entitled "Thoughts on Ray Vibrations“
  -> light should be interpreted as a field much like the magnetic fields…

- A. Gershun, 1936

  „The Light Field“ - „[…] we shall introduce the concepts of the light field, as a part of space studied from the standpoint of transmission of radiant energy within that space […]“

- H.-J. Helwig, 1950

  „Die Feldtheorie in der Lichttechnik“ – In illuminating engineering as well as in electrical engineering one deals with spaces where electromagnetic waves pass through […], so we can create an adapted theory from the electric field to a light field […] (translated by author)

- Moon & Spencer, 1981

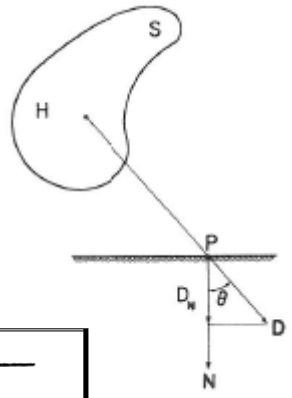
  „The Photic Field“ – „[…] Maxwell‘s equations can be applied to photic-field problems. […] the photic field is quite distinct from Maxwell‘s electromagnetic field […]“

Light field theory: indicators

Luminous flux density – pharosage D

Helios H = pharosage per unit solid angle

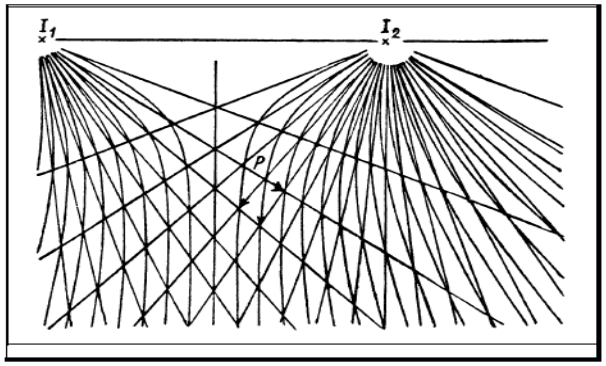
Light vector



source: Moon, Spencer, 1981

Flow of light

Luminous flux



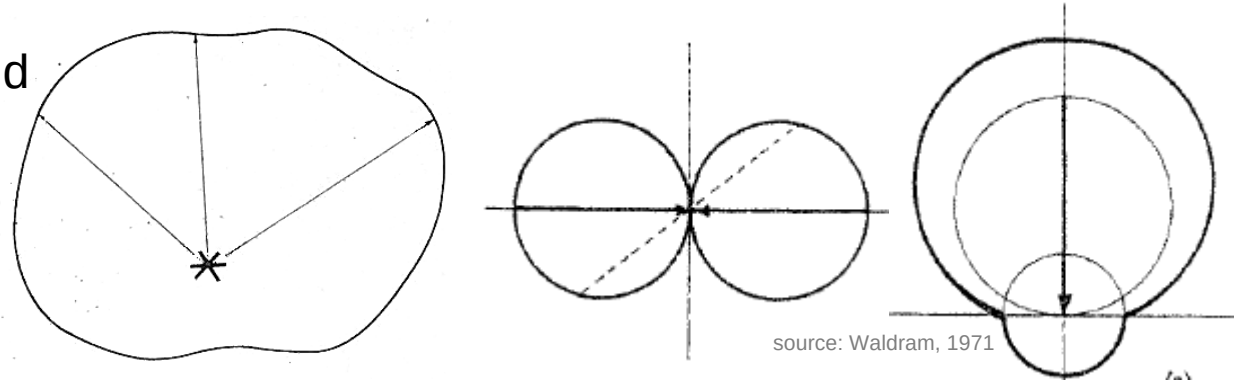
source: Helwig, 1950

Luminance distribution solid

Illumination solid

Vector component

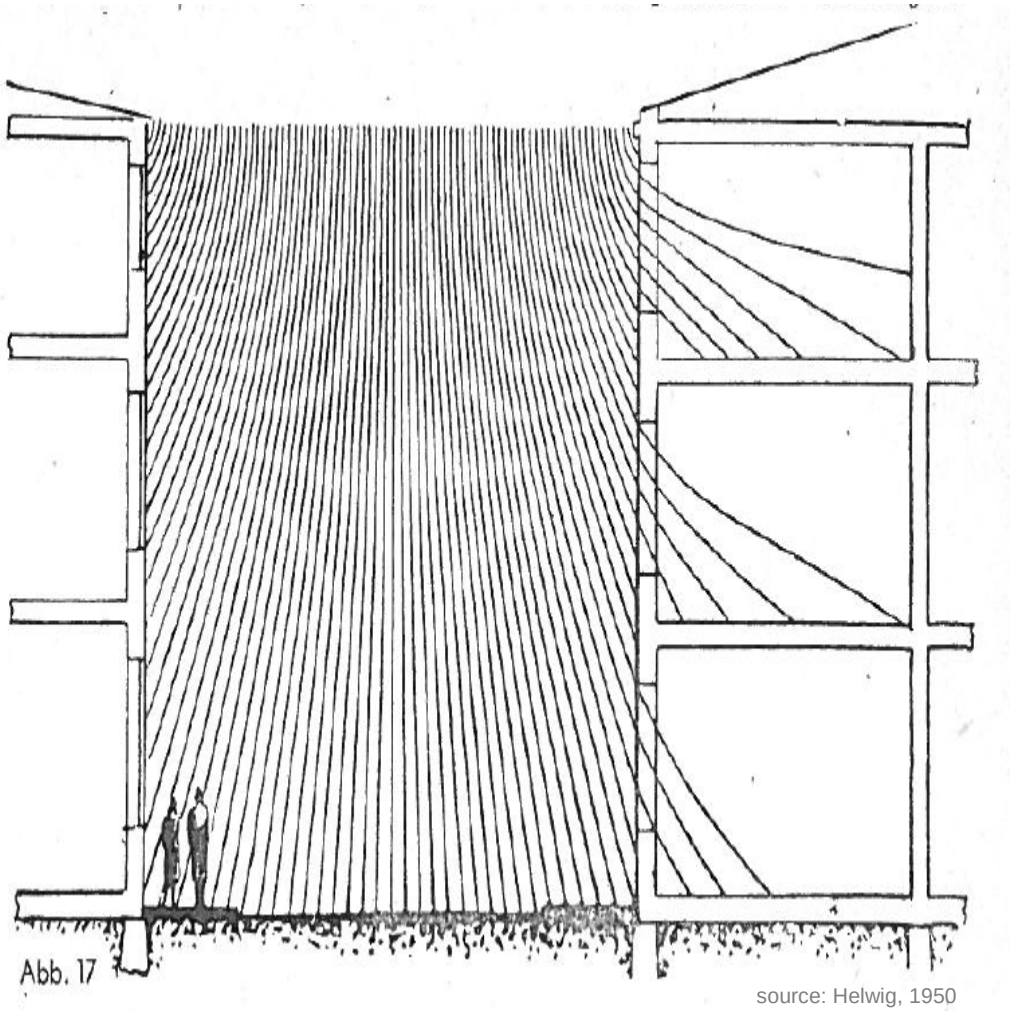
Symmetric component



source: Waldram, 1971

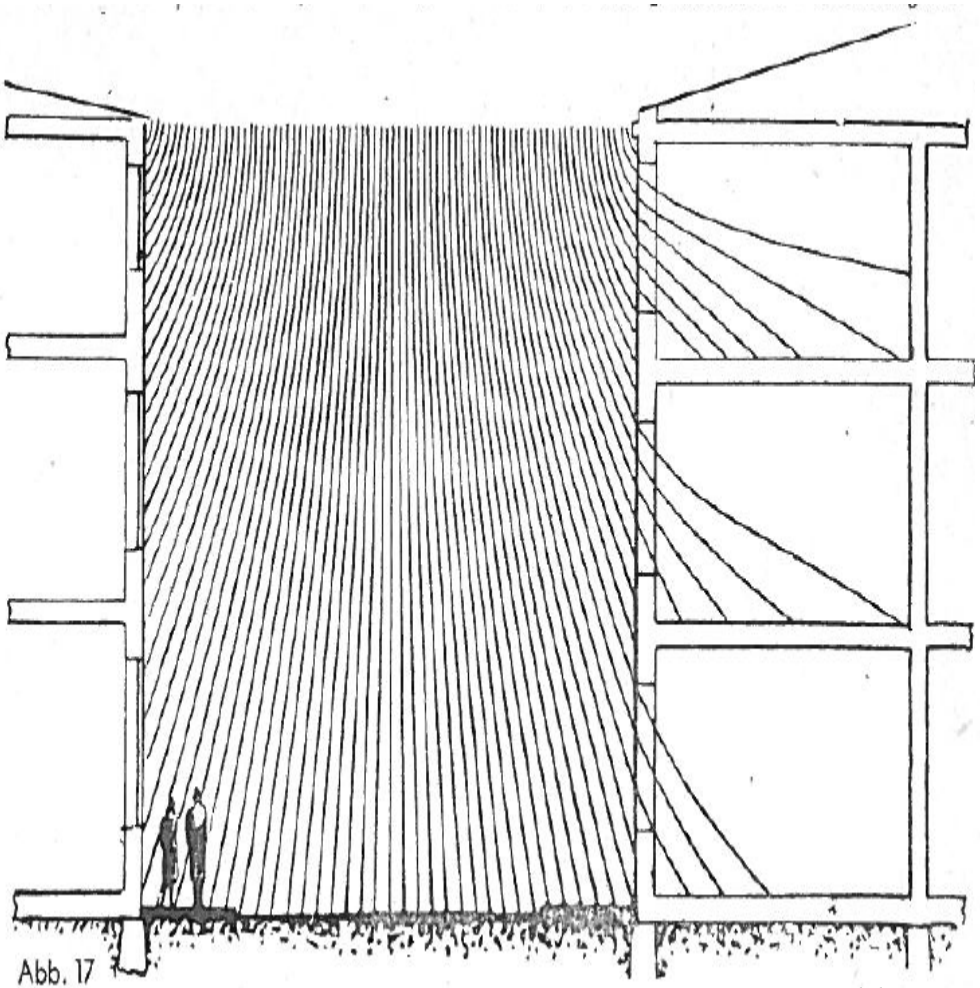
Light field: daylight

source: http://www.flickr.com/photos/13818157@N05/2331387505/

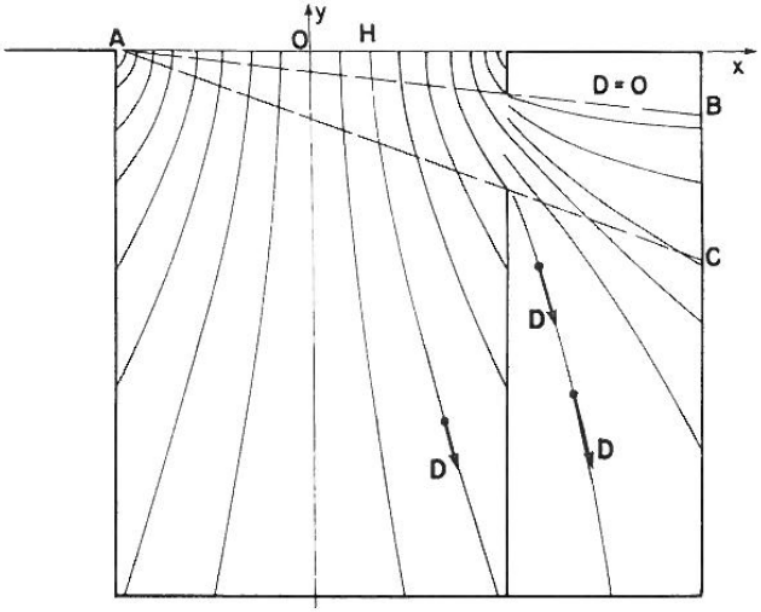


source: Helwig, 1950

Light field: daylight



source: Helwig, 1950



source: Moon, Spencer, 1981

Light field: daylight

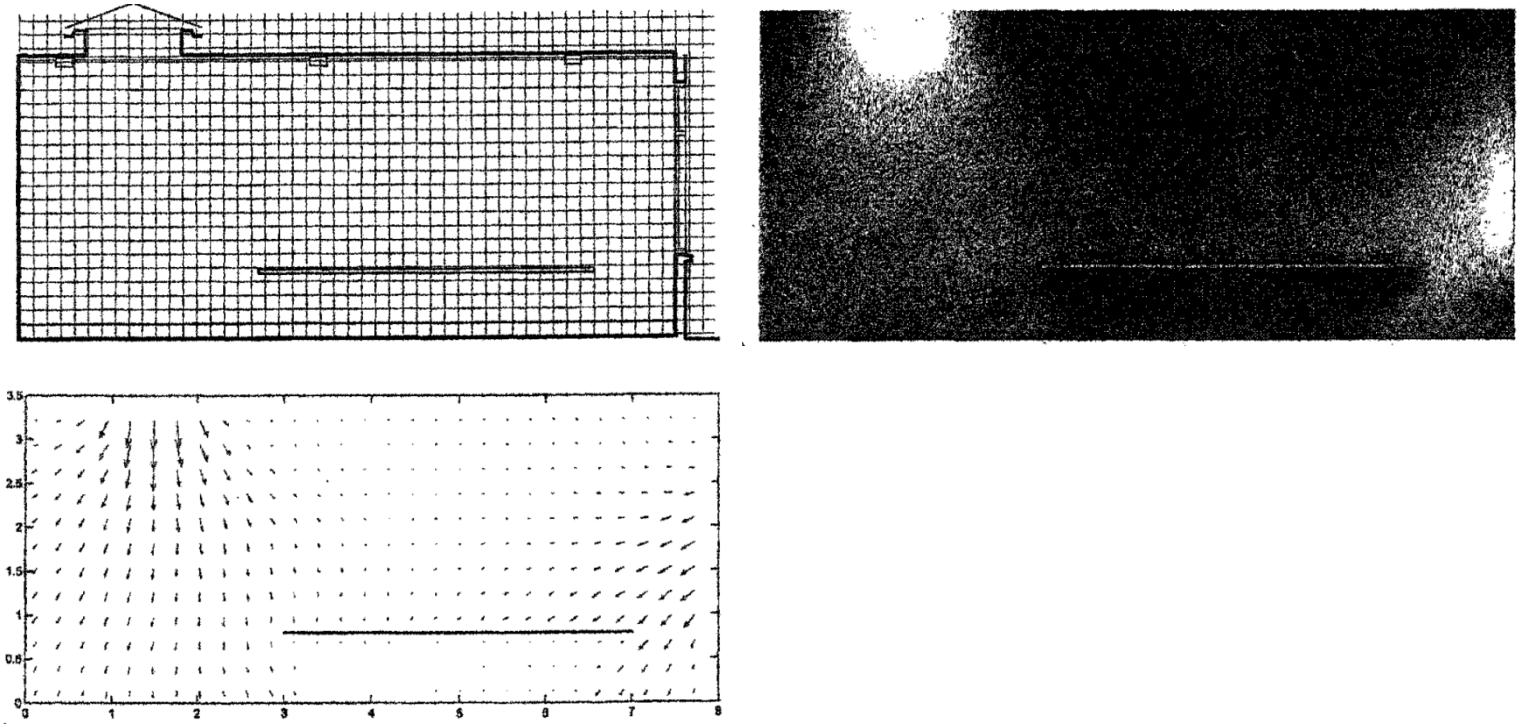


Figure 10 Computed luminous energy field in a room lit by a side window and a rooflight: (a) scale of the spatial grid; (b) density plot of mean spherical illuminance, using three-colour simulation; (c) vector field of mean luminous flux

(P.R. Tregenza, 2002)

Light field: daylight and artificial lighting

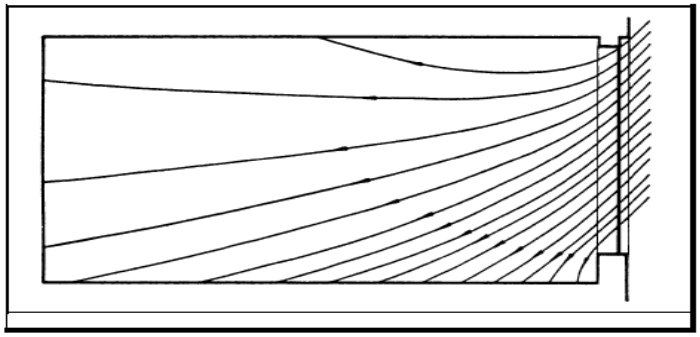


Bild 9.13:
Lichtfeld von durch ein Fenster eintretendem Himmelslicht.
(Cuttle u.a.: "Beyond the working plane", CIE Proceedings, 1963)

Light field by incident skylight

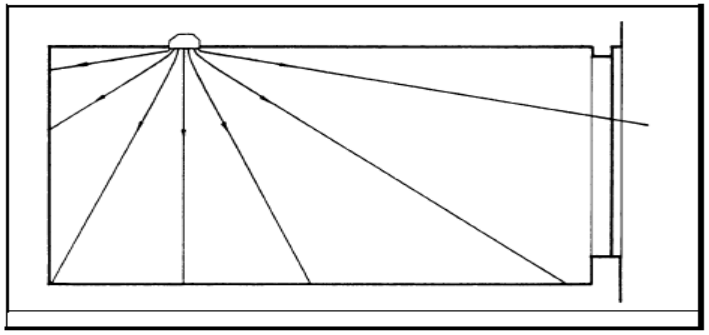


Bild 9.14:
Lichtfeld einer einzelnen Punktlichtquelle in einem Raum.
(Cuttle u.a.: "Beyond the working plane", CIE Proceedings, 1963)

Light field by a point light source

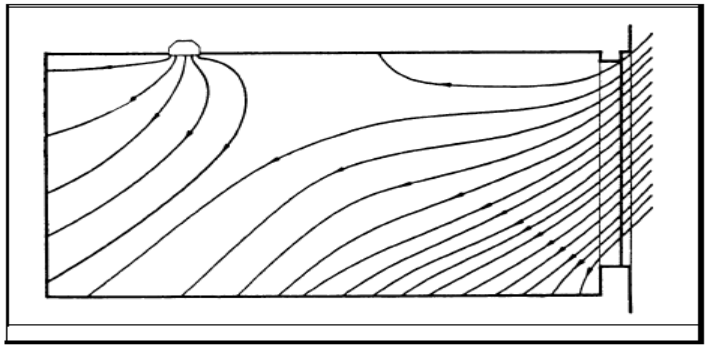
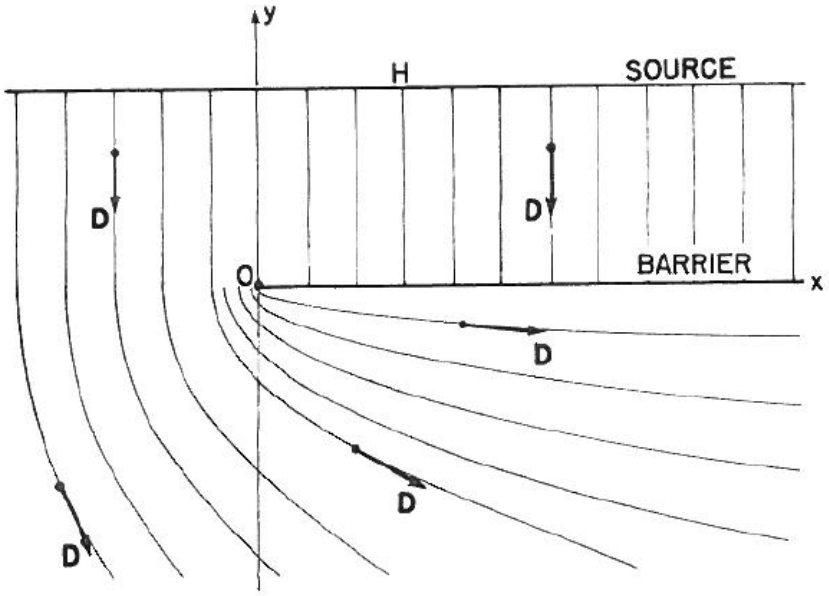


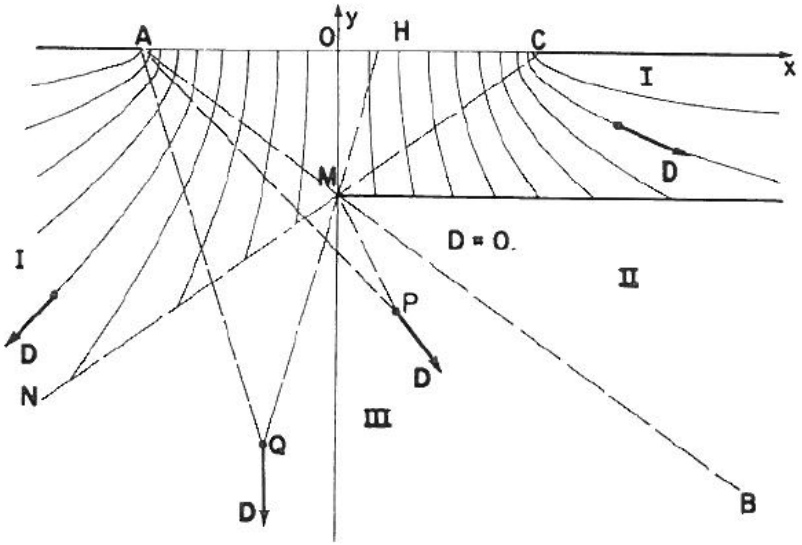
Bild 9.15:
Überlagerung der Lichtfelder von Bild 9.13 und Bild 9.14.
(Cuttle u.a.: "Beyond the working plane", CIE Proceedings, 1963)

Superposition of both light fields

Examples: Light field and barriers



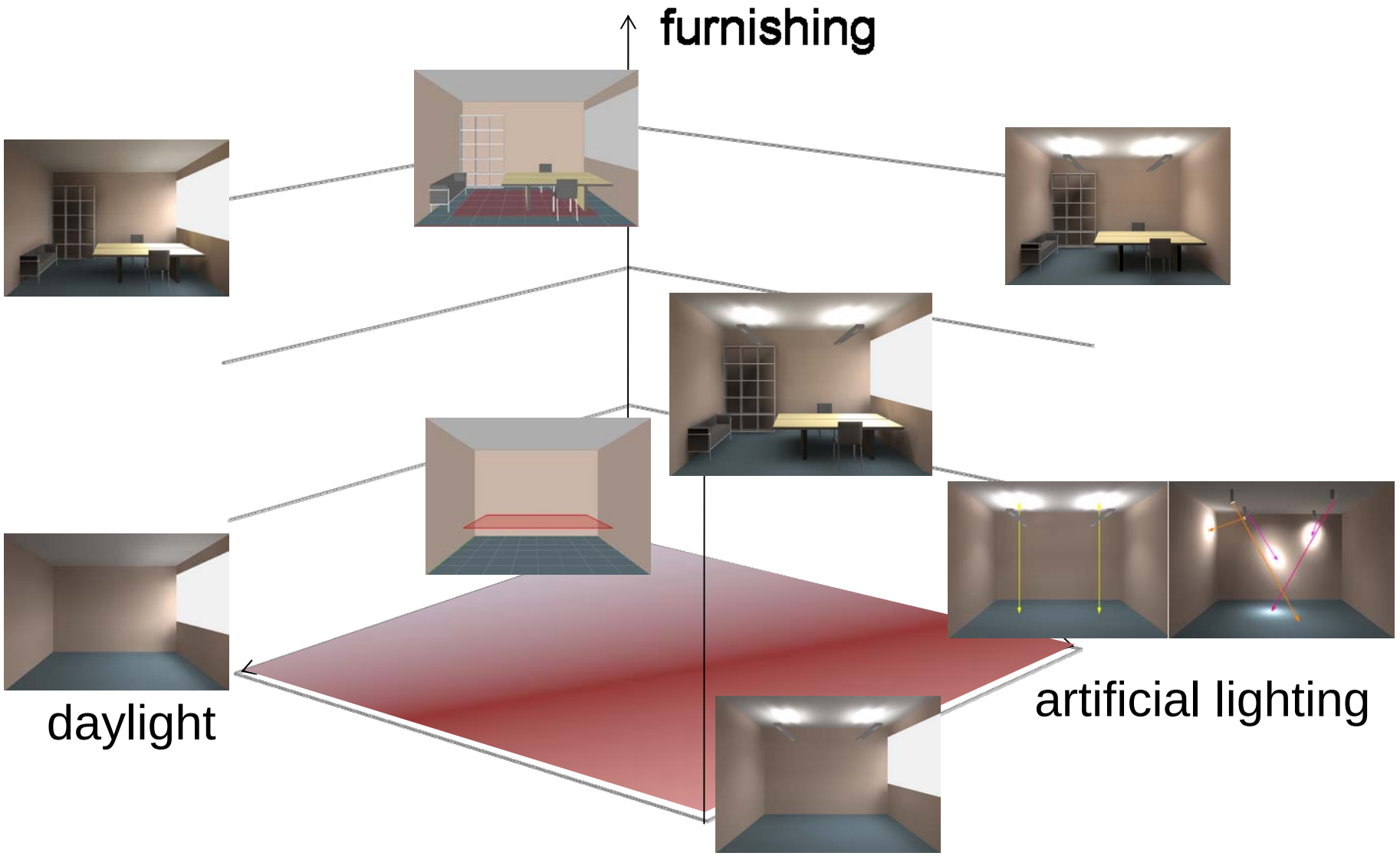
source: Moon, Spencer, 1981



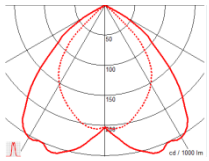
source: Moon, Spencer, 1981

Figure 5.15
Uniform-strip source with barrier.

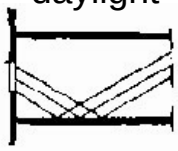
Designing the light field



The Black Box



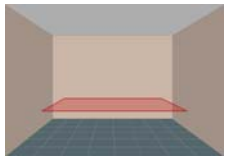
daylight



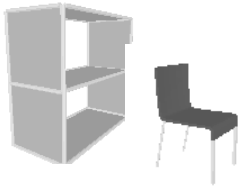
luminous intensity distribution

light

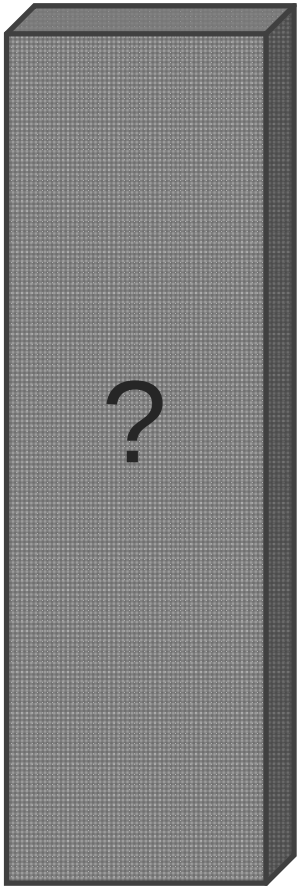
room



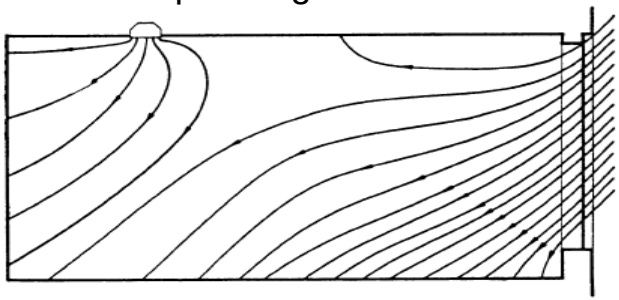
Reflectance, transmission
of materials of the room
and interior



interior



spatial light field



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Thank you for your attention and discussion!