Development of a stochastic model to calculate 1-minute short-time-step dynamics of daylight.

Reference:

Step 1: Normalization
Short Time Step Dynamics

Short-Time-Step Dynamics of Daylight

7AM to 8 AM

2PM to 3PM
Short-Time-Step Dynamics of Daylight

Envelope Design
For daylighting it is useful to conceptually divide a façade into three roughly equally sized areas, a "daylight" top part, a "view" central part, and a "balustrade" bottom part.

- The daylight area has maximum benefit for admitting daylight deep into a space.
- The view area mainly serves for "view to the outside" purposes.
- The balustrade has limited use for daylighting.

**Daylit Area in the Reference Office for six Façade Combinations**

- Plan
- Section
- Perspective View
Divide the Façade into a View and a Daylighting Area

Fraunhofer Institute for Solar Energy Systems, Freiburg
Architecture Dissing and Weitling, Copenhagen
Photo: Karsten Voss

Façade Study

Daylit Area 100% DA_{mean} = 89%
Daylit Area 80% DA_{mean} = 76%
Daylit Area 73% DA_{mean} = 69%
Daylit Area 73% DA_{mean} = 69%
Daylit Area 44% DA_{mean} = 46%

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Fraunhofer ISE - Borrowed Daylight on an Aisle

Integration of Daylighting with nighttime cooling.

Mount Angel Library

- rectilinear plan oriented east-west with fan-shaped space
  skylight facing North (no louvers)
  probably due to north-sloping topography + views towards agricultural lands

Mount Angel Library

Photographs of skylight and interiors of Mount Angel Library removed due to copyright restrictions.

- skylight with adjacent reflective surface to capture and redistribute daylight predominantly overcast skies in Oregon

General Design Advice for Massing Studies and Envelope Openings

⇒ If possible reduce floor plan depth to less than 5-7 times the floor to ceiling height.
⇒ Introduce setback on higher floors to increase the sky access for lower levels.
⇒ Introduce atria, skylights and clerestories.
⇒ Place window as high as possible near the ceiling.
⇒ Higher surface reflectances make rooms appear larger.
⇒ A vertical/horizontal window near a bright wall/ceiling makes a room appear wider/higher.
Daylighting Techniques for Sidelit Spaces

- Provide movable shading only for the view area and control the daylighting area either automatically or add a complex fenestration system such as an external or internal lightshelf, a laser cut panel, and overhang, external louvers or a translucent panel.
- Work with the ground immediately adjacent to your façade.
- Desirable reflectances to have a well daylit environment: ceiling > 80%, walls > 50-70%, floor > 20-40%, furniture > 25-45% (avoiding specular surface finishes).

Occupant Comfort and Well-being

Design Advice

- Use daylight for full spectrum color rendering
- Balance a view to the outside with occupants’ privacy (perforated shades)
- Avoid low solar angles onto facades.
- Maintain daylighting levels within acceptable limits
- Develop a suitable shading device strategy (Shading from neighboring buildings, Venetian Blinds, Light shelves)
- Avoid work places too close the exterior glazings
Daylighting Techniques

Split Blind Study

Close-up and interior view of a split blind system in the Lamparter Office Building near Stuttgart, Germany.
Split Blind Study

Daylit Area 69%
DAmean = 65%
Lighting = 2.4 kWh/m² yr

Daylit Area 44%
DAmean = 46%
Lighting = 4 kWh/m² yr

Daylit Area 65%
DAmean = 60%
Lighting = 2.4 kWh/m² yr

Bauhaus Dessau
moullions: outside black, inside white

Project: Bauhaus Dessau, Germany (1925)
Architect: Walter Gropius

Photo: Karsten Voss

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German Reichstag

Project: Reichstag, Berlin, Germany (constructed 1894; renovated 1999)
Architect: Paul Wallot, Norman Foster (renovation)

- sunlighting vs. daylighting (daylight redirecting cone)
- powerful symbolism of 'the people' walking on top of their parliament

Photo by Michael Stephens on Flickr.

Arthelio - Lightpipe

Project: demonstration project in the Semperlux Building, Berlin, Germany (2000)
Project management: Technical University of Berlin

Integration of daylighting and electric lighting (sulphur lamp).

Photo: Alex Rosemann

Courtesy of Alexander Rosemann. Used with permission.
Butterfly System

Research Project: University of British Columbia, Canada (2005)

Prototype of a new light-redirecting daylighting system.

National Art Gallery

Project: National Art Gallery, Ottawa, Canada (1988)
Architects: Moshe Safdie

Photos: A. Rosemann

Courtesy of Alexander Rosemann. Used with permission.
New York Times

Project: New York Times headquarters Building (under construction)
Architects: Renzo Piano, Fox & Fowle
Research Project: Lawrence Berkeley National Laboratory

Largest installation of automated lighting and dimming controls in North America.

NY Times Design Goals

“There should be no place where an employee does not see natural light and a view.”

Cruciform shape of the building brings more light into the space and gives employees near-panoramic views.

Open plan offices near the windows, private offices against the core.

Generous floor to ceiling height of 9'-7" with 10'-4" height in the five foot band by the windows.

Floor to ceiling clear low-iron glass (SHGC=0.39, T=0.75) made possible by the exterior ceramic rods.

Rendering of the NYTimes headquarters removed due to copyright restrictions.

Floorplan of NY Times Headquarters removed due to copyright restrictions.
Research Project: Energy/Comfort Performance in a Full-Scale Mockup

Furniture, daylighting, employee feedback and constructability: ~450 m², 4500 sf mockup

Core Concerns:
- Window glare (Tv 0.75)
- Daylight harvesting potential

Northwest  Southwest corner of a typical floor

Investigate diverse technological solutions by multiple vendors

more info under: [http://windows.lbl.gov/comm_perf/newyorktimes.htm](http://windows.lbl.gov/comm_perf/newyorktimes.htm)

Automated roller shades

Courtesy of Gregory Ward. Used with permission.
Lighting energy savings: West window zones

Lighting energy savings: SW corner zones

 Courtesy of Gregory Ward. Used with permission.
Radiance Simulation – different floors

Courtesy of Gregory Ward. Used with permission.

Daylighting Pattern Guide

http://patternguide.advancedbuildings.net/
Daylight Design Variations Book

http://sts.bwk.tue.nl/dkylight/varbook/index.htm

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4.430 Daylighting
Spring 2012

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