

green building strategy

Daylighting Design Examples

contents

Bilateral	2
Toplighting	9
Sidelighting	12
Exterior Shading	21
Additional Resources	29





"Buildings, too, are children of Earth and Sun."

-Frank Lloyd Wright

"I use light abundantly, as you may have suspected; light for me is the fundamental basis of architecture . I compose with light."

-Le Corbusier

Daylight is a free natural resource that has a significant impact on occupant and building performance. A building that successfully integrates daylight can reduce its overall energy consumption, while improving occupant comfort and health, and productivity.

Buildings that maximize the use of daylight can reduce energy consumption and first costs for the project. Good daylighting design can significantly reduce the use of electrical lighting. Artificial lights produce heat which must be addressed by the building's HVAC system. By reducing the need for artificial lights during peak periods (usually coincident with the maximum available daylighting), the cooling demand can be reduced. Reduced cooling demand in turn can mean smaller HVAC systems than a typical building reducing that system cost.

Human beings are profoundly impacted by the environment. Daylit spaces are typically the most desired spaces in a building for a very simple reason, humans naturally prefer daylight. The diurnal changes each day from light to dark, the changes in light from season-to-season, and even the amount of light related to the phases of the moon affect people's mood and health. Exposure to daylight regulates our circadian rhythms, which when disrupted can have negative effects, primarily on certain brain functions. Our species has evolved for millennia to establish this rhythm. It is only in the past hundred years or so that we have attempted to substitute artificial light for natural light. Recent research demonstrates that people are not as healthy or productive as those in a building that is more directly connected to the natural environment.

Quality daylighting design basically follows some of the same criteria as good artificial lighting design such as uniformity, quality and quantities. Improperly designed daylight can be a major liability, properly designed a significant asset. The following pages include examples of buildings that have integrated good daylighting elements into their design. We hope to inspire you with good ideas that could be incorporated into your designs.

Bilateral

A space is considered to have a bilateral condition when there is glazing on two or more walls or a combination of side lighting and top lighting scenarios are used. Bilateral daylighting scenarios provide a more even distribution of daylight in the space and reduces the conditions of glare and contrast that are more prevalent in side lighting scenarios. Optimal daylighting performance is obtained with bilateral lighting.



Providing glazing on both long axis walls of gymnasiums allows an even distribution of daylight in the space. The orientation of the space may require translucent glazing to be used as was in the Ferguson Elementary gym.

Ferguson Elementary School
York, PA
EI Associates

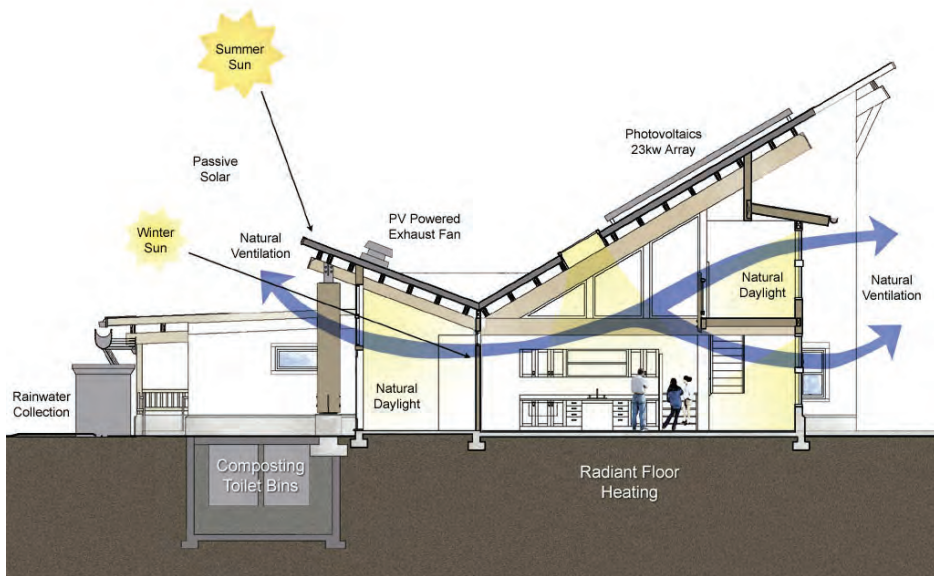
Bilateral scenarios are also a combination of side and top lighting scenarios which was implemented successfully at the Associated Mennonite Biblical Seminary Library.



Associated Mennonite Biblical Seminary Library
Elkhart, IN
The Troyer Group



Multi-media Center



Island Wood School in the Woods
 Bainbridge Island, WA
 Mithun

With bilateral daylighting scenarios, other green design strategies, such as cross ventilation are made easier.



Nash Central High School
 Rocky Mount, NC
 Boney, PLLC



Thomas L. Wells
Scarborough, Ontario Canada
Baird Sampson Nevert Architects

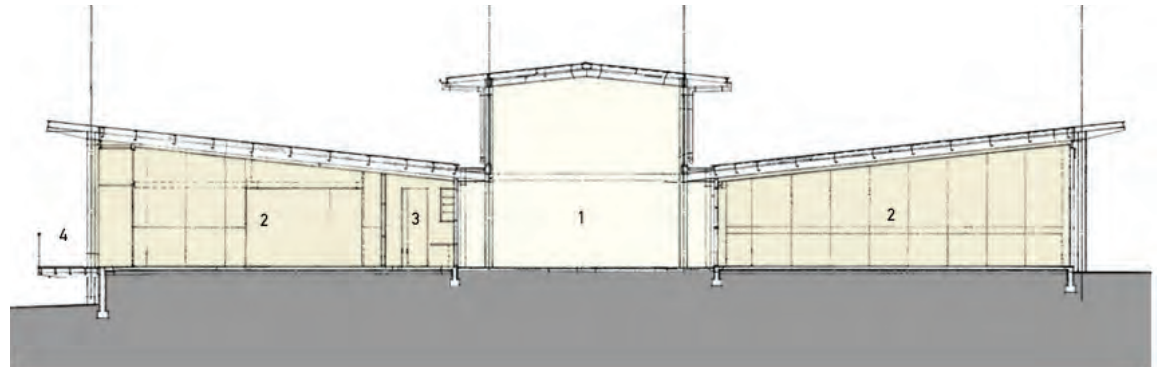


Willowbank Primary School
Auckland, New Zealand
ASC Architects



Somerville Intermediate
Auckland, New Zealand
ASC Architects

A double loaded corridor with toplighting helps bring in daylight to the back of deep spaces. It is possible for this type of configuration to be orientated with the long axis running north/south instead of the typical east/west axis. Climate and daylight analysis are needed to ensure the reduction of thermal loads and proper daylight quality and quantities.



Somerville Intermediate
Auckland, New Zealand
ASC Architects

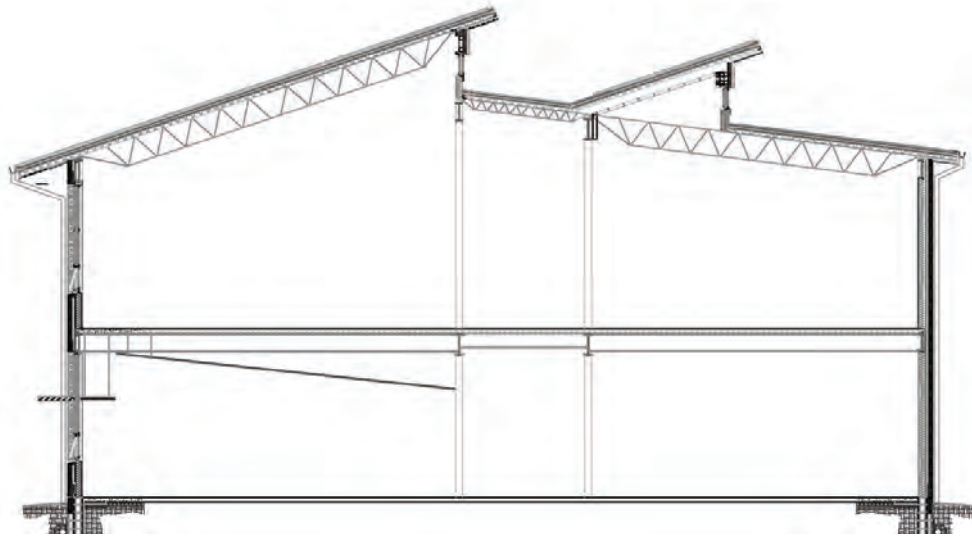


Carmel Mountain Ranch Library
San Diego, CA
M.W. Steele Group, Inc.



Carmel Mountain Ranch Library
San Diego, CA
M.W. Steele Group, Inc.

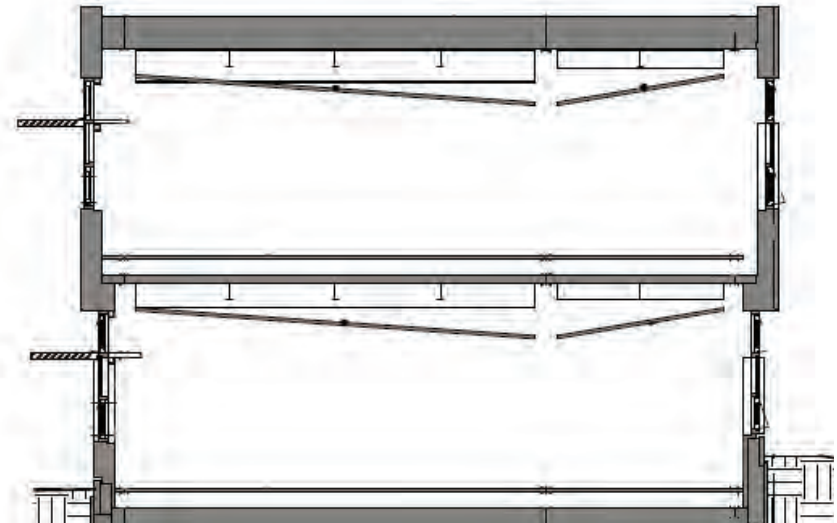
The Carmel Mountain Ranch Library is orientated northwest/south east, that is the reason for the lower roof on the southwest facade. This type of space design can be stand or alone or part of a larger building depending on the space activity.



Ferguson Elementary School
State College, PA
Schrader Group Architecture

Roof geometry can provide ideal situations for bilateral daylighting scenarios. With Ferguson Elementary, the sloped roof configuration provides the optimal angles for north facing clerestories.

With an open office space such as at the Center for Sustainable Landscapes, sloping the ceiling helps increase the illuminance levels further into the space.



Center for Sustainable Landscapes
Phipps Conservatory
Pittsburgh, PA
The Design Alliance

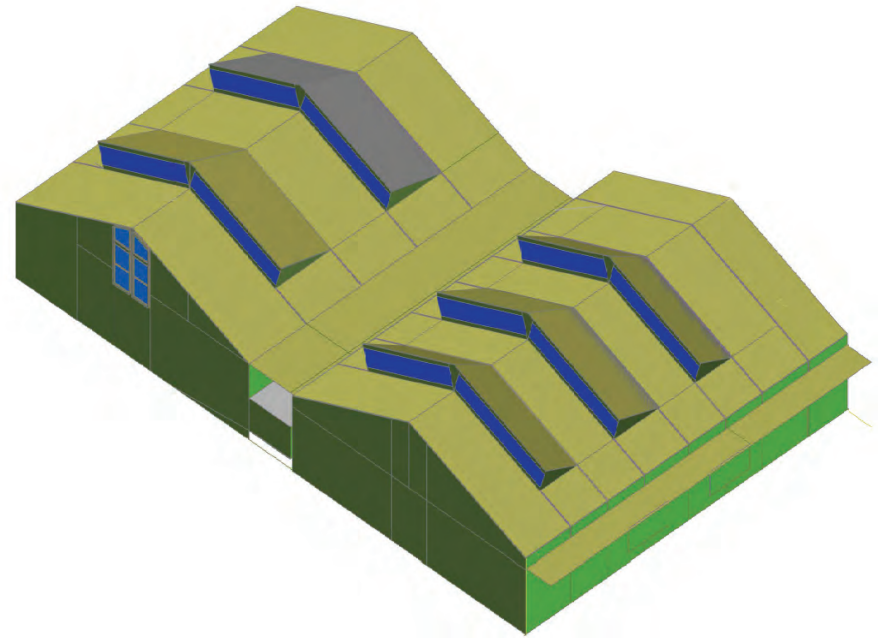
Toplighting

There are many options when it comes to toplighting. The three basic scenarios are skylights, clerestories, and monitors, all of which can be modified to meet the daylight needs of the space. Toplighting is an effective means to get daylight into a space that is located in the interior of a building or where sidelighting scenarios cannot provide effective daylighting.

North Facing clerestories provide daylight without the concern for direct solar penetration. The clerestories at the Angela Athletic Center were part of a retrofit and addition that provides ample amounts of daylight.



Angela Athletic Center
Coraopolis, PA
L.F. Gilbert Architects, Inc.



The image above is the roof plan for the Angela Athletic Center Gymnasium showing how the north facing clerestories are designed.



Heritage School
Wake Forest, NC
Innovative Design

Toplighting scenarios require the proper spacing and size of openings in a space to reduce glare. Baffles, as used in the Heritage School, are a strategy to minimize direct solar issues.

Large opaque skylights are better suited for spaces with tall ceilings. This reduces glare and better distributes the light throughout the space. Heat from the skylight will stratify in the higher spaces keeping the occupants cooler.



Nazareth Middle School
Nazareth, PA
Architecture Furst



DEP Norristown
Norristown, PA
L.R. Kimball & Assoc.



Marshall Fields Department Store
Chicago

A large central atrium is one strategy to bring daylight into buildings with large floor plates. In certain climates, this strategy could be used in conjunction with stack ventilation.

Sidelighting

Side lighting, daylight entering from one side of a space, is the most common method of daylighting. Daylight penetration and distribution is not as effective as bilateral or toplighting, but there are design strategies that can be successfully employed.

The general rule of the thumb for sidelighting is that daylight will penetrate from 1.5 to 2 times the window height. Therefore, spaces that can only use sidelighting without the aide of lightshelves should have windows placed as high as possible.



Almond Elementary
Los Altos, CA
Gelfand Partners Architects



Almond Elementary

The daylight window is separate from the view window. By placing the daylight window as high as possible, daylight penetration is greater than what would occur with a standard window height.

In some scenarios, such as in gymnasiums and work shops, glazing cannot be located at standard sill height. However, by placing the glazing near the ceiling and across the entire space, daylighting can be successfully implemented.



Neptune Community School
Neptune, NJ
SSP Architectural Group, Inc.



Botany Downs Secondary School
Auckland, New Zealand
ASC Architects



Pequa Valley Elementary School
Gap, PA
E.I. Associates

The amount and type of glazing will be different for each facade of the building and for spaces with different activities. Typically, south facing spaces have a 15% window to floor ratio where north facing spaces have 20%.

The Pequa Valley Elementary School has a window to floor area ratio of 17% for the north facing windows and uses a high VLT glazing. Because of this balance, the north facing classrooms are daylighted effectively. The images below show a north facing classroom under partly cloudy skies at 11am near the spring equinox.



Pequa Valley Elementary School
Gap, PA
E.I. Associates



Mt. Airy Public Library
Mt. Airy, NC
Mazria/Schiff Assoc.

Mt. Airy Public Library in North Carolina uses many of the typical daylighting strategies. Windows are set back in the facade so that the exterior shading is part of the facade and not just a stuck on design element. When exterior shading devices and interior light shelves are used, a balance between the daylight and view windows are critical.



Mt. Airy Public Library
Mt. Airy, NC
Mazria/Schiff Assoc.

The Santa Rita School uses design strategies to daylight a very deep space by implementing clerestories windows halfway into the space. This design is somewhat of a hybrid of side and toplighting, but since the light from the lower and upper windows combine and are not separate light sources in the space, this is an example of successful sidelighting.



Santa Rita School
Los Altos, CA
Gelfand Partners Architects



Santa Rita School
Los Altos, CA
Gelfand Partners Architects



Thomas L. Wells Public School
Scarborough, Ontario Canada
Baird, Sampson, Nevert Architects

The Thomas L. Wells School is a good example of a balanced window area with lightshelves to provide a good quality of light in the space, reduced glare and contrast.

Solar shades should be used instead of typical blinds to allow the visual connection between interior and the natural environment.

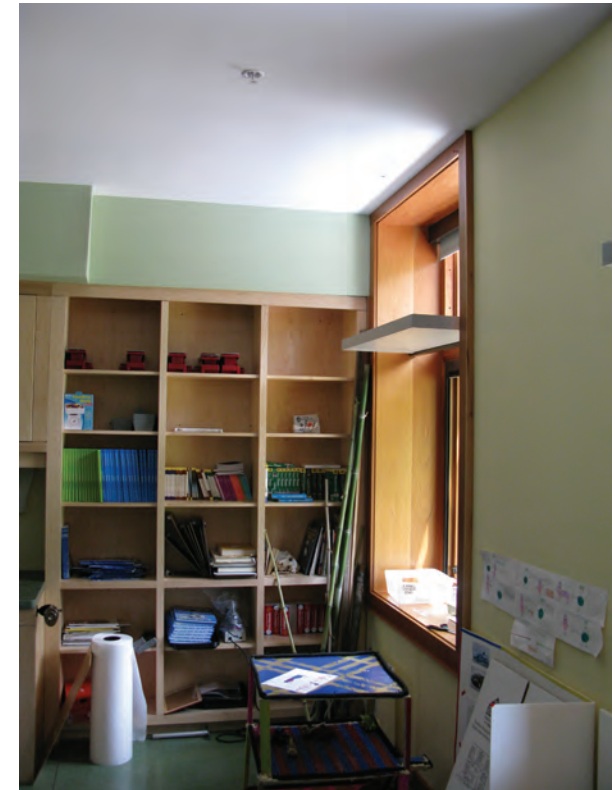


Solar shades

The use of lightshelves increases the daylight penetration to almost 2.5 times the window head height. They can be used in conjunction with exterior shading devices or by themselves.



Nazareth Middle School
Nazareth, PA
Architecture Furst



The Willow School
Barn Studio
Gladstone, NJ
Hone + Associates

Lightshelves should be as thin as possible. This will help reduce contrast issues along the window wall, material costs, and allow more glazing area.



Center for Energy & Environmental Education
University of Northern Iowa
Wells Woodbourn O'Neil

Lightshelves can serve multiple purposes which help reduce first costs. The entry lobby in the CEEE building uses large lightshelves to help define the entries study alcoves.

Classrooms in the CEEE uses the perimeter duct work as the lightshelf. Typical design usually puts perimeter heating above the head of the window.

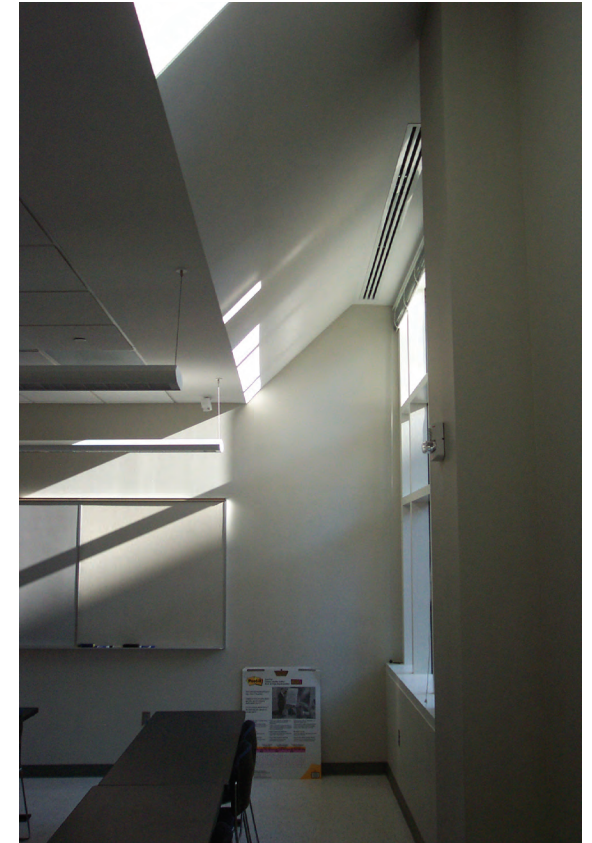


Center for Energy & Environmental Education
University of Northern Iowa
Wells Woodbourn O'Neil

Sloping the ceiling from the window like UNCC or stepping down the ceiling at Nazareth, is an effective strategy to providing as much window area as possible when floor to ceiling heights are limited due to the HVAC system.



Nazareth Middle School
Nazareth, PA
Architecture Furst



UNC Charlotte College of Education
Charlotte, NC
Gant Huberman Architects PLLC

Exterior Shading

Exterior shading is more of a concept than an actual element. The concept is to reduce unwanted daylight and solar heat gain while still maintaining views to the exterior and keeping the needed daylight. Shading can be landscaping, attached shading devices, or the building itself.

Exterior shading should be as much a part of the building structure as possible. The architecture should actual self shade itself.



Horizon Middle School
Ferndale, WA
Wise Miller Architects

Some building designs in some latitudes require that exterior shading be added as a tertiary element. It is critical that no thermal bridging occurs when these elements are attached.



Bentley Park College
Cairns, Australia
Department of Public Works



Ferguson Elementary School
York, PA
E.I. Associates



Langston High School
Arlington, VA
Beeryo Architecture+Interiors

Overhanging upper floors is one means of providing shading. This may be more feasible in some climates than others due to the increased number of outside walls in these scenarios.



Millbrook Elementary
Raleigh, NC
Innovative Design

By setting the windows back into the facade, low morning and evening sun angles can be mitigated.

The strategy used at the Smith Middle School allows more light to enter the daylight window. This is a very good strategy in climates where overcast skies are more prevalent.



Smith Middle School
Chapel Hill, NC
Reece, Noland & McElrath



Lewis and Clark State Offices
Jefferson City, MO
BNIM Architects

Exterior shading devices may need to extend beyond the edges of the glazing to effectively reduce direct solar impacts in the interior.



DEP Cambria
Ebensburg, PA
L.R. Kimball Assoc.

It can more effective for spaces that have high window head heights to stack exterior shading louvres as shown on both of these projects. Analysis will help determine spacing and location,



Windmill Hill 500
Great Britain
Michael Aukeft & Partners



HACC Select Medical
Harrisburg Area Community College
Harrisburg, PA
L.R. Kimball Assoc.



DEP California
California, PA
L.R. Kimball Assoc.

Exterior shading devices should be used above the window when interior light shelves are not used. They are the most effective on the south, east and west facades.



Center for Energy & Environmental Education
University of Northern Iowa
Wells Woodbourn O'Neil

Site constraints required the main orientation of the Alberci Headquarter to face southwest. To minimize the effects of low angle afternoon and evening sun, spaces are orientated directly south. This saw tooth design reduces solar impacts and provides self shading to these spaces.



Alberci Corporate Headquarters
St. Louis, MO
Mackey Mitchell Assoc.



Pequa Valley Elementary School
Gap, PA
E.I. Associates

The best way to provide exterior shading is to let the architecture shade itself. This can be cost effective and the more integrated as compared to some attached shading strategies.



The Willow School
Barn Studio
Gladstone, NJ
Hone + Associates

Exterior shading devices can take on many forms and sizes. The slim design of the shades at the Willow School does not diminish the aesthetics and in some instances it appears that there are no shades at all.

Exterior shades above the window work in the same manner as roof overhangs, as shown at the Summerfield Elementary School. These shades do not need to be metal. They can be fabric awnings and even retractable.



Summerfield Elementary School
Neptune, NJ
E.I. Associates

Additional Resources

Books and Manuals

Daylighting for Sustainable Design, Guzowski, Mary

Daylight Performance and Design, Gregg D. Ander

Daylighting, Natural Light in Architecture, Derek Phillips

Websites

Daylighting Design Tips and Services

www.sevengroup.com

www.betterbricks.com

Daylighting Design Tips and Case Studies

www.wbdg.org/resources/daylighting.php

www.algonline.org

www.thedaylightsite.com

www.lrc.rpi.edu/programs/daylighting/index.asp

www.daylighting.org

www.lrc.rpi.edu

Case Studies

www.designshare.com

The logo for 7group, featuring a large, stylized green number '7' followed by the word 'group' in a lowercase, sans-serif font.

183 West Main Street

Kutztown, PA 19530

+1 610 683 0890

www.sevengroup.com