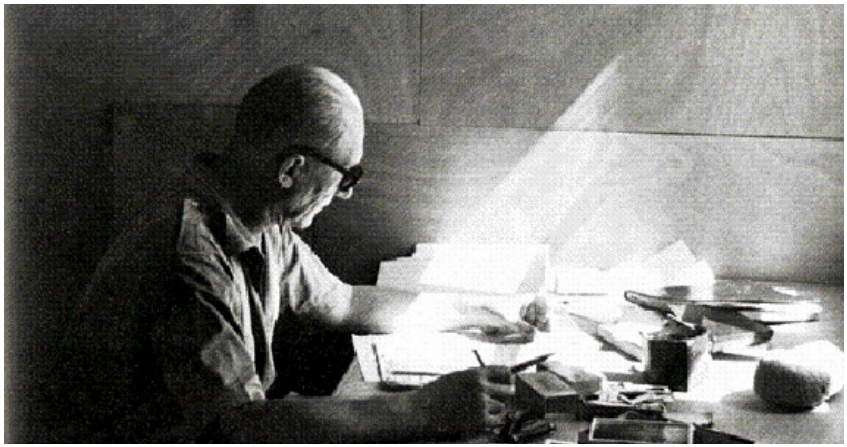

"Architecture is the masterly correct and
magnificent play of masses brought together in light.
Our eyes are made to see forms in light
and shade reveal these forms"

Le Corbusier

Daylighting

This booklet is a compilation of articles, research papers, and books focusing on various aspects of daylighting in architecture. The booklet consists of a number of abstracts, extracts, and introductions, which may serve as a key to and an inspiration for further readings on the subject. All included material has been sampled from the Internet, and the full text material is available at www.architectstudent.net.

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Back to Basics: Daylighting

Article by Christina Trauthwein, Editor-in-Chief,
Architectural Lighting Magazine, US

A common approach to bringing daylight indoors incorporates a light-shelf system into the architectural design.

Key words

Daylighting, static and dynamic components, passive and active techniques, building design, interior design, window coatings and films, transmission media, heliostats and tracking devices, "smart windows", which is the right solution?

Extracts from the article

Architect Mies van der Rohe (1886-1969) said, "The history of architecture is the history of man's struggle for light - the history of the window." Today, that struggle goes on and with the new choices in technology and design techniques, it appears to be increasingly winnable for the architect and lighting specifier. Of course, we're talking about daylighting, the technique that uses direct, diffused or reflected daylight to provide general or supplemental lighting for building interiors.

Daylighting is employed to achieve the benefits of a more satisfied workforce by helping occupants feel connected to the outdoors; to reduce ongoing energy costs; and to potentially increase the lease or capital value of the building by offering a more pleasant environment. In some spaces, dramatic aesthetic effects are possible. However, to be successful, the daylighting scheme must allow daylight to provide maximum penetration into the building; ensure that it will work with an overcast sky and a clear sunlight sky (unless one of these conditions predominates in the given region); and avoid undesirable heat gains, direct and reflected glare, veiling reflections, creation of unwanted shadows and excessive brightness and light uniformity ratios.

A simple way to look at daylighting is to break the design problem down into its static and dynamic components. We have the sun - the most powerful and dynamic light source of all - whose useful daylight must be captured and distributed. With a clear sky, daylight can be captured as a direct (excellent CRI, cool light source) and reflected element; with an overcast sky, it can be captured as a reflected element. We have the stationary shape and form of the building itself and its electric lighting system. To harness direct and reflected daylight and get it into the building where it's needed, we have transmission media, which include windows, glazing, skylights, light shelves, baffles, blinds, interior surfaces and other media that direct, diffuse and reflect the sunlight. Another component is controls, which can be employed to make the electric lighting system interact with ambient sunlight via dimming or switching.

In the article, there is focus on transmission media, which can be further broken down into two types, passive and active.

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Find the complete material on the Web.

www.architectstudent.net/library/back_to_basics

Daylighting - a Practical Approach

Thesis by Leony Sze-Hui, The University of Australia, Australia

Key words
Daylighting, direct benefits, major issues, strategies for effective lighting design, innovative daylighting systems, light pipes, mirror louver systems, prismatic systems, sunlight directing prisms, sunlight excluding prisms, laser cut panels, advanced glazing technologies, electrochromic glass systems, liquid crystals, photochromics, lighting design, lighting for visual function, lighting for visual amenity, lighting and architectural integration, energy efficiency, lighting maintenance, integration of daylight with electric light.

Introduction
Lighting is a critical factor in the visual experience of environments, in the performance of tasks, and in the use of energy in buildings. This paper discusses the potential of daylighting as an approach to lighting design.

Daylighting has been an implicit part of building design for almost as long as buildings have existed. The evolution of the window, responding to functional requirement, technological opportunity and cultural influence, has consistently enriched architecture through centuries, only to lose its sense of direction in the post-fluorescent era of the last forty years.

Lighting has often been described as a subject that encompasses both art and science. Although there are various ways of interpreting this thinking, it can be seen as balancing those things which are objective and which can be measured relatively easily, against those that can be described as subjective and cannot be measured using conventional means. Most designers have long believed that these two aspects are equally important, but perhaps because of the lack of experimental evidence in support of the subjective, the balance has been heavily weighted towards the objective and its associated numerical criteria.

Daylight, in particular, is generally considered to be a very welcome component of interior illumination. Indeed so much has been said and written about the useful contribution that daylight can make to artificial illumination, that its aesthetic contribution is sometimes overlooked.

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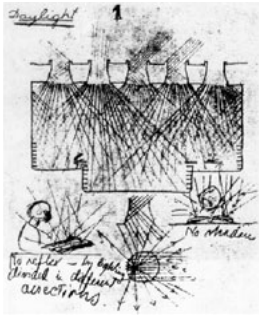
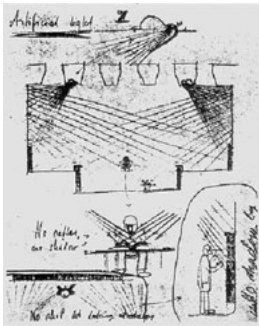
Find the complete material on the Web.

www.architectstudent.net/library/daylighting_a_practical





Sketch of expected proposed daylighting distribution in the distribution from electric lighting Viipuri Municipal Library fixtures. (Alvar Aalto, preliminary study sketches for the Viipuri Municipal Labrary 1927-1935).

Musée des Tumulus de Bougon, Bougon, France.

Daylighting in Buildings

Maxi Brochure issued by the Energy Research Group, University College Dublin for the European Commission Directorate General for Energy (DGXVII), Republic of Ireland

Key words
Visual comfort, daylight as resource, daylight and energy, daylighting data, costs, daylighting design, rooflights, atria, glazing, transparent insulation, lightshelves and reflectors, lightpipes and lightducts, shading, artificial lightning, integrated controls, retrofit, tools, case studies.

Introduction
It is difficult to overestimate the significance of daylight, and of sunlight, in the character of a building and in the lives of the people who use it. Most interiors which are to be occupied by people, as opposed to goods or machinery, need plenty of light, and until the middle of this century the limits of natural lighting were critical determinants in the plan of a building and in the design of its external envelope.

The arrival of fluorescent lighting and cheap energy made possible the multi-storey, deep-plan building where the ratio of usable floor area to external envelope was taken to its maximum. The energy crises of the 1970s together with recognition of the damage we are causing to the biosphere have been two of the factors encouraging a return to natural light and ventilation in buildings. Another, which is becoming increasingly significant, is the response of human beings to working in a wholly artificial environment.

There is concern about 'Sick Building Syndrome'. Many factors - low humidity levels, bacteria and dust particles carried through poorly maintained air-handling systems, toxic emissions from building materials, flicker from fluorescent lamps, and daylight deprivation - have been implicated in a range of conditions from Legionnaires' Disease through asthma, Seasonal Affective Disorder, chronic headaches and rhinitis, to non-specific malaise. But there is growing recognition that the more direct and rewarding solution may lie in a renewed emphasis on natural light and ventilation.

Attempts to prove a direct relationship between productivity and the presence of daylight and views of the outdoors have been inconclusive, but research does show that people value the variety of daylight, enjoy the presence of sunlight in a building, and want at least a glimpse of the world outside.

Historically, fine buildings have always exploited natural light and, after a brief interlude, the skillful use of daylight is once again being seen as a critical element in the design of buildings of high architectural quality.

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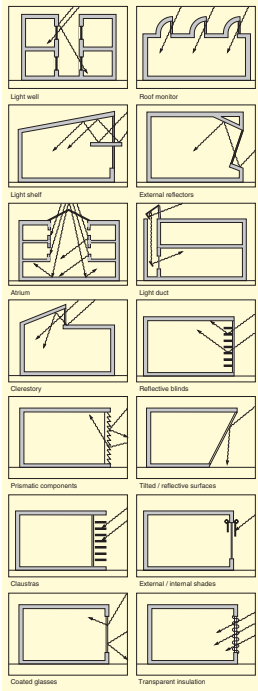

Daylighting devices

Skylights as a Light Source

Web article by Mojtaba Navvab, Architectural Lighting Magazine, US

The Caldarium bath at Pompeii, Pompeii, Italy.

Key words
Skylight technology, daylight distribution, design factors, zonal cavity method, latest research.

Extracts from the article

Recent advances in skylight technology - such as major refinements in aluminum extrusions, high-performance scalers, and better glazing - have made improved and increasingly complex designs possible. Those improvements, in turn, have earned designers' appreciation of skylights as energy-saving light sources that yield high satisfaction among building users. Formerly, designers commonly perceived skylights as the cause of weatherproofing problems.

Among other things, skylights can be used to satisfy a building occupant's need for contact with the outside. They enhance the interior environment by admitting light and heat. Because skylights as a light source are dependent upon the sun, changes are expected in the intensity and distribution of light admitted during the course of a day. The sun's earth orbital cycle and atmospheric variables, such as clouds, create a more dynamic environment than does uniform interior lighting. People respond favorably to the variations in brightness and changes in color caused by bringing outdoor light indoors.

Depending upon the design of the skylight system, daylight distribution can be localized or uniformly spread over a large task area. For many types of buildings, the skylight is an enhancement or complement to the interior appearance and electric lighting of the building. Besides being attractive and having a favorable impact on the senses of occupants, properly applied skylights can save energy while bringing the outdoors inside. Increased use of skylights has forced designers to search for more detailed skylight information and data in order to make the best use of them in many building types. The skylight industry has responded by examining many of the current systems and techniques in order to assist architects and designers with skylight applications.

Architects and lighting designers have to factor the following functions into their designs: geographic location of the building, light well geometry, light distribution, thermal and visual comfort, reflections, color and texture of adjacent surfaces, cooling loads and costs, and heat loss.

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Find the complete material on the Web.

www.architectstudent.net/library/skylights_as_a_light

Advanced Fenestration and Daylighting Systems

Web article by Ross McCluney, Ph.D. Principal Research Scientist, Florida Solar Energy Center, US

Key words
Natural lighting (daylight illumination), high-performance glazing, reflecting systems, tubular skylight, solar lighting systems, complex fenestration systems, louvers, exterior shading screens, spectrally selective glazing, advanced fenestration energy and illumination performance, annual energy and illumination performance calculations, references.

Extracts from the article

Advanced fenestration and daylighting systems form an interesting new class of devices and products for introducing natural lighting (daylight illumination) into buildings. They are split into two distinct classes.

Advanced fenestration systems are new high-performance glazing and reflecting systems for otherwise conventional windows which offer specialized spectral and/or angular selectivity, intended for improved illumination quantity and quality while managing solar radiant heat gain to meet both human comfort and energy conservation objectives. These spectral and/or angular selectivities can be built into the glazings, incorporated into new objects placed between the panes, or they can be part of objects attached to the interior or exterior frames of the windows. The class includes a wide variety of fenestration attachment products, such as shades, blinds, screens, fixed and movable louvers, and even mirrored surfaces for re-directing the daylight entering fenestration apertures. This class also includes several novel new glazing types such as those containing electrochromic and holographic layers, still in the research stage.

The second class of systems, advanced daylighting systems, includes those manufactured by a new solar lighting industry, whose products are targeted at what has been called "core daylighting" because they are intended to introduce daylight into the core spaces of multistorey buildings, spaces distant from the building envelope, or in other locations where more conventional daylighting apertures cannot be placed. Solar lighting systems include the widely available tubular skylights offered by many manufacturers in the U.S., Canada, and other countries around the world, and a variety of new systems just entering the market (or being prepared for future market entry).

Solar lighting systems are fairly recent innovations, and haven't yet experienced widespread use. Both categories include complex devices whose performance is difficult to predict and quantify for all locations and seasons.

The article is based on an invited paper for 'Daylighting '98', an international conference on daylighting technologies for energy efficiency in buildings. 10-13 May 1998, Ottowa, Canada.

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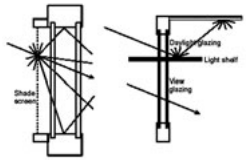
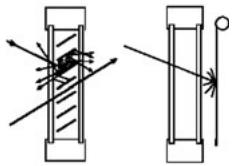
Find the complete material on the Web.

www.architectstudent.net/library/advanced_fenestration



Exterior shade screen and light shelf advanced fenestration systems.



Between the panes and interior shades make for complex windows.

Notre-Dame du Haut,
Ronchamp, France.

To Capture the Sun and Sky

Article issued by Lighting Research Center,
Rensselaer Polytechnic Institute, US

Key words
Daylighting strategies, perimeter daylighting systems, light shelves, prismatic glazing, holographic films, passive skylights, active skylights, what's next for daylighting?

Extracts from the article
The sun is a source of free, plentiful light, and daylighting - the method of lighting building interiors with sunlight and diffuse skylight - is an effort to reap this bounty. The use of advanced daylighting technologies, such as light pipes, active skylights, and improved windows, may increase the amount of daylight available inside buildings. These technologies are attractive, but do they work and are they cost-effective? The most effective daylighting strategies may still be the simplest: optimized building orientation and form, optimized window size and placement, a light switch, maybe a light shelf.

Bringing the light inside
Daylighting provides light that supplements or replaces electric lighting; the addition of daylight in a space may also bring benefits related to aesthetics, health, and energy savings. Perimeter daylighting systems, such as windows, bring daylight about 15 feet into a building. Core daylighting techniques bring daylight deeper into a building. However, the application of traditional core daylighting methods, like atria and courtyards, is limited by building height and design. Many building owners are reluctant to turn what could be rentable space into a daylighting atrium.

Different daylighting techniques
Prismatic glazing. Refraction is the principle behind prismatic glazing, a material with ridges on one side that bend light to specified angles.

Holographic films. Holographic films, which are attached to a window appear clear except at the diffraction angle.

Passive skylights. The common skylight, or roof window, provides a simple way of bringing daylight to the upper floor of a deep building.

Active skylights. Active daylighting systems contain moving parts that track the sun.

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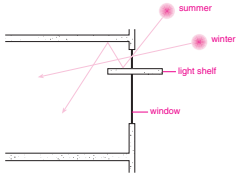
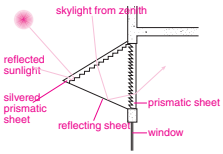
www.architectstudent.net/library/to_capture_the_sun



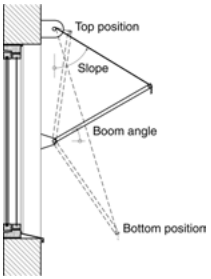
A light shelf that divides a window into a view section below and a clerestory section above.



A prismatic system made by Siemens that excludes direct sunlight and admits skylight from near the zenith.

Solar Shading Project

Research paper issued by Department of Construction and Architecture, Division of Energy and Building Design and Division of Building Science, Lund University, Sweden



Section through window with awning, and definition of boom angle and slope.

Key words

Solar protection, solar shading, windows, buildings, energy need, heating, cooling, measurement, calorimetric, solar energy transmission, shading coefficient, calculation, design aid, solar simulator, user aspects, comfort, daylight.

Introduction

Buildings with well-functioning solar protection can cut the investment cost for cooling and ventilation installations, reduce energy use and create the conditions for good thermal and visual comfort. Since there is a lack of scientifically developed and comparable data available for the physical properties of solar protection devices, the research project Solar Protection in Buildings, described in this report, has been put in hand. The aim is to determine, by measurements and calculations, the physical properties of different types of sunshades. Design aids for the construction industry must be developed and a standardised laboratory method should also be developed for measuring the physical properties of solar protection devices. Measurements have been made and calculation models developed for external sunshades. A design tool, mainly for external sunshades, is being developed and the first version was released in September 2000.

A solar simulator has been constructed so that measurements on windows and sunshades can be made in a more standardised manner. Calculations have also been performed to study the effect of sunshades on energy use for heating and cooling, and a preliminary investigation has also been made with regard to user aspects and the effect on daylight in rooms when sunshades are used. The results at this stage comprise values determined for the solar energy transmittance of external sunshades such as awnings, Italian awnings, external venetian blinds, horizontal slatted baffles, fabric screens, slatted blinds and solar control films. Calculation models for these types of sunshades have been developed and show good agreement with measurements.

Calculations with the new sunshade models implemented in the energy balance program DEROB-LTH show that there is considerable potential for reducing energy needs where seasonally adapted solar shading is used. The results indicate that automatic regulation of sunshades, which can however still be overridden by the users, is the optimum solution.

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www.architectstudent.net/library/solar_shading_project

The Environmental Building

Research paper issued by Building Research Establishment Ltd. (BRE), UK

Key words
Passive ventilation/cooling, solar control and daylighting, lighting, photovoltaics.

Extracts from the project description

The new Environmental Building at Garston has been built as a demonstration building for the Energy Efficient Office of the Future (EoF) performance specifications, drawn up by a number of companies representing the manufacturers, designers and installers of building components and the fuel utilities, as part of the EoF project run by BRECSU. A key part of this specification is the need to reduce energy consumption and CO_2 emissions by 30% from current best practice. Air conditioning is not used in the new building – the major energy consumer in many existing office buildings. Other savings will be made by making better use of daylighting and by using the building's 'thermal mass' to moderate temperatures.

To make maximum use of available daylight, the building has a large glass area, carefully optimised to provide high light levels but low heat losses and solar gain. To prevent excessive heating and glare from the sun shining in - the 'blinds down, lights on' situation common in many offices on sunny winter days - the building has a system of Colt motorised glass louvres on the south facade to control the daylighting levels. Each louvre has a translucent ceramic coating on the underside which obscures the direct sunshine whilst still letting diffuse light through.

During the day, the angle of the louvres changes according to the position of the sun. At times when direct sunshine is not a problem the louvres are angled to act as 'light shelves' - reflecting light off their smooth upper surface onto the ceilings of the offices. This reduces the amount of artificial lighting needed in the parts of the offices furthest from the windows. Like the other control systems in the building, the automatic control can be overridden by the occupants. By using a TV-style remote control unit, users send a signal, which is picked up by a sensor in the office lighting units. This is passed through the LonWorks network to the Trend management system, which operates motors on the individual louvre units.

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www.architectstudent.net/library/the_environmental_building

The need to build a new office building at BRE's Garston site was an ideal opportunity to put new ideas to the test.

The Pantheon,
Rome, Italy.

DayMedia

Interactive website issued by Low Energy Architecture Research Unit (LEARN), University of North London, UK

Key words

Use of daylight, controlling daylight, active control devices, blinds, venetian blinds, passive control devices, light shelves, comparing clear glazing with diffuse glazing and light shelves, tinted glazing, transmitting daylight, light pipes, sun ducts, fibre optic illuminators, light chimneys, integrating daylight and artificial light, time switching, occupancy linked control, daylight linked control, localised switching, minimising the operating costs, preferences in artificial lighting, nature of daylight, sky types, availability of daylight, diffuse horizontal illuminance, global horizontal illuminance, probability of certain sky types, frequency of overcast skies, frequency of clear skies, the path of the sun, simulating daylighting, quality of daylight, criteria of daylight, daylight factors, no-sky line, measuring light, colour temperature, contrast and glare, glare from windows, glare from VDUs, modelling ability of daylight, maximising daylight, reflectances, room reflectances, reflected light from outside obstructions, reflected light off the ground (albedo), introducing plants, effects of the building exterior, penetration of sunlight, height of an outside obstruction and orientation, glazing, glazed roof, optimal glazing in an atrium, building geometry, atrium dimensions, case studies, daylighting of hospitals, daylight Europe.

Introduction

DayMedia is a multimedia teaching package for daylighting in architecture. It is partly funded by the 'Leonardo da Vinci' programme of the European Commission.

Although daylight used to be the primary source of light for the interior, the skills of daylighting have become lost in the past 40 years. In the context of the threat of global warming, we face the urgent need to reduce the energy consumption of our buildings. The European Commission has been promoting the use of renewable and alternative energy sources with research, demonstration and dissemination grants.

DayMedia was developed as a flexible teaching tool for university students and small and medium enterprises. It tries to meet the needs of European professionals with regard to the use of daylighting techniques in buildings. It also aims to transfer and disseminate the expertise in daylighting design developed in EC research programmes. DayMedia tries to help architects and building engineers rediscover the skills of making sustainable buildings.

DayMedia is not a reference book on a screen and therefore does not pretend to be comprehensive. It uses both interactive and non-interactive images to demonstrate the principles of daylighting. Downloadable interactive website (13.1 MB). Can be used online too.

This project is a part of the EU 'Leonardo Programme' which funds Low Energy Architecture Research Unit (LEARN), University of North London.

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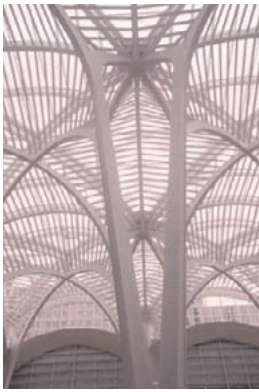

A linear atrium of a covered street in Toronto.

Tips for Daylighting with Windows

Web book issued by Building Technologies Program Energy & Environment Division, Ernest Orlando Lawrence Berkeley National Laboratory, University of California, US

Key words

The integrated approach, daylight feasibility, envelope and room decisions, glazing selection, shading strategy, mechanical coordination, lighting coordination, sensors and controls, calibration and commissioning, maintenance, cost benefit analysis, glossary, references, tools and resources summary.

Introduction

These guidelines provide an integrated approach to the cost-effective design of perimeter zones in new commercial buildings. They function as a quick reference for designers through a set of easy steps and rules-of-thumb, emphasizing "how-to" practical details. References are given to more detailed sources of information, should the reader wish to go further.

No guidelines can answer all possible questions from all types of users. However, this document addresses the most commonly occurring scenarios. The guidance here is limited by the medium; short paper documents can only go so far in assisting a designer with a unique project. This document has been carefully shaped to best meet the needs of a designer when time does not permit a more extensive form of assistance.

The design method used in this document emphasizes that building decisions should be made within the context of the whole building as a single functioning system rather than as an assembly of distinct parts. This integrated design approach looks at the ramifications of each individual system decision on the whole building. For example, the glazing selection will have an effect on lighting, mechanical, and interior design. Therefore, the entire design team should participate in and influence this decision - which typically rests with the architect alone. The benefit of an integrated design approach is a greater chance of success towards long-term comfort and sustained energy savings in the building.

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www.architectstudent.net/library/tips_for_daylighting

Saving Energy with Daylighting Systems

Web Maxi Brochure issued by CADDET Centre for Energy Efficiency, UK

Key words
Vertical windows, coatings, shading devices, atria and glazed streets, rooflights, prismatic, clerestories, light shelves, light ducts, lighting control systems, reflective ceilings, other benefits of daylighting, technological advances, demonstration projects, automatic blinds, light tunnels, daylight control, glossary, references, useful Internet sites.

Introduction
Daylighting is the efficient use of natural light in order to minimise the need for artificial light in buildings. A well thought out building designed with daylighting in mind can have a number of significant benefits for building owners and occupants. Increasing levels of daylight in rooms can reduce electrical lighting loads by up to 70% in some cases.

Building occupants generally prefer a well daylit space, provided that attention is paid to avoid the problems of glare and overheating. Studies also suggest it is beneficial in terms of health and productivity. However, despite the potential benefits, daylighting design often receives little attention. In 1997, solar design was estimated to be a feature in between 20,000 and 30,000 private homes and only a few hundred other buildings in Europe. However, very few of these buildings incorporated a fully designed daylighting strategy. Daylighting differs from other environmental services in that it is a fundamental element of architecture, while electric lighting or mechanical heating and cooling systems are add-on services that architects can hand over to the building services engineer.

When lighting specialists are employed it is rare for them to be asked, or be able, to advice on daylighting. Even when architects plan the window design it is rarely thought of as a lighting element that can provide visual quality and utility, but more as an element of the facade and a view to the outside world.

This Maxi Brochure looks at the latest and most commonly used daylighting techniques.

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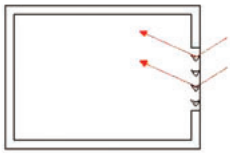
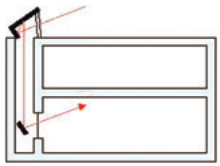
Find the complete material on the Web.

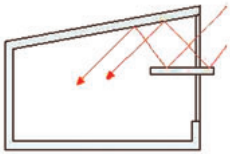
www.architectstudent.net/library/saving_energy



Schematic of daylighting using reflective blinds.



Schematic of a light duct.



Schematic of a light shelf.

Kings Cross Station,
London, UK.

Daylighting Offers Great Opportunities

Article by Gregory Franta and Kristine Anstead, American Institute of Architects (AIA), US

Key words
Daylight, health and productivity, daylight exposure, contact with the outside, examples on daylight building design, references.

Extracts from the article

Today, there is increasing evidence that daylight is essential for the health, well-being and productivity of individuals. Although productivity is often difficult to quantify, clinical disorders, such as daylight deprivation and seasonal affective disorder (commonly called SAD), are directly linked to a person's lack of light. By carefully designing window specifications for either commercial or residential buildings, architects can contribute to the increased productivity and psychological health of building occupants.

Through the years, daylight has played an invaluable role in the lighting of buildings. Until the industrial revolution, workers generally spent a large amount of time outdoors or within close proximity to daylight. Not until this century, when electric lights became common, has daylighting been neglected in most buildings.

A recent study indicates that typical people are exposed total daylight levels of greater than 2000 lux for only 90 minutes each day (Savides, 1986). Light exposure is important to the inner time keeping of humans. Through evolution, man has adapted to rhythms such as body temperature to provide him with explicit knowledge of external time (Terman, et al, 1987). The loss of this connection can contribute to fatigue, insomnia, and SAD. Another study of Russian and Czechoslovakian literature indicated that occupants of factories without windows were more subject to headaches, faintness and sickness then similar occupants of factories with windows (Plant, 1970). However, with today's advanced window technology, combined with efficient electric lighting, we can now design cost-effective, healthy buildings, that help to minimize these effects. Daylight, a full-spectrum light source, most closely matches the visual response that, through evolution, humans have come to compare with all other light. Daylight provides continually changing values, brightness and contrasts to the workplace, allowing the human eye to constantly adjust. This adjustment reduces eye fatigue. The human eye is capable of adjusting to high levels of luminance without producing discomfort (AIA, 1993). However, reflections and brightness need to be controlled in relation to the task or design program.

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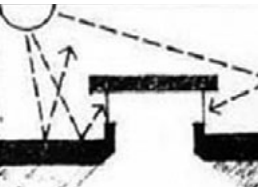
Find the complete material on the Web.

www.architectstudent.net/library/daylighting_offers_great

Natural light is especially critical in the case of hospitals and other such facilities. Wood windows bring light into the interior of The Way Station, a mental health facility in Frederick Md.

Daylighting Strategies: Skylighting in Hot Dry Climates

Article by Warren R. Hampton, Arid Lands Newsletter, US



Sunlight reflected from adjacent roof and building surfaces is an important component of skylighting in hot dry climates.

Properly designed skylighting devices can function as windcatchers and/or vents for convective air currents.

A coffered ceiling is an effective method for distributing light uniformly within a space without creating discomfort from glare.

Key words

The skylighting option, orienting building masses, preserving the thermal integrity of the building envelope, reflections from the roof surface and adjacent building surfaces, detailing openings through the roof and ceiling, tinted glazing, reflectances of interior surfaces, designing for natural ventilation, simulation and testing, references.

Extracts from the article

This article might have been entitled "An Alternative to the Well-considered Window." While this author strongly advocates skylighting as a unique and utilitarian form of natural lighting for spaces in hot dry climates, he does not recommend elimination of windows designed for view and ventilation. Windows alone, however, do not provide satisfactory daylighting of deep spaces due to poor penetration and distribution of the illumination within the space; this can result in glare and local overheating.

Skylighting in combination with properly designed windows can effectively illuminate deep interior spaces and offers opportunities for natural ventilation. To allow the penetration of daylight into a building interior requires the architect or lighting designer to evaluate two components of sunlight: the thermal and the luminous. This evaluation should include the analysis of thermal gains and illumination from direct solar radiation, and from diffuse sources such as the skydome and adjacent reflective surfaces including the ground itself. It is important to consider aperture size as a function of light transmission and its resultant thermal impacts upon the building interior.

Improperly designed apertures can result in overheating of the interior spaces, visual discomfort from glare and unwanted deterioration and fading of furnishings and other materials. Daylighting in hot dry climates requires an integrated design approach toward energy performance of the building envelope and illumination of the interiors.

Architectural morphology must respond to passive heating, cooling, and ventilation requirements, and be properly configured to capture and distribute natural illumination effectively and efficiently to the interior spaces. The architect or lighting designer must sensitively apply the design principles for thermal performance and actively pursue the investigation of options using computer simulation and photometric model testing.

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www.architectstudent.net/library/daylighting_strategies

Medical aspects of lighting

Web article by Dr. -Ing. Ahmet E. Çakir, ERGONOMIC Institut, Germany

Key words
Human life is governed by the sun, town planning and sunlight, the relationship between vitamin D and sunlight, light therapy, SAD, industrial buildings and daylight.

Extracts from article

The biological evolution of the human race is believed to have taken place under the sunlight of African planes were the rhythm of day and night is approximately 12 hours throughout the year. Even after moving north and establishing the first concentrated residential areas like villages and towns about 10,000 years ago in the area known today as Turkey, human life remained governed by the sun. Until the invention of railway transportation and the use of coal, the sun remained the main energy and light source. Even ancient "big" cities and the houses in them were planned and built for optimum exploitation of the sunlight with Priene being one of the most characteristic examples of ancient solar architecture. In some respect, avoiding the effects of sunlight was a second aspect which, however, was not of secondary importance. In some areas of the world, the entire architecture had its main focus on this aspect. The size of the cities was determined by the socalled wood collecting range which means that residential areas could not grow beyond a distance which marked the range where collecting wood would consume more energy than gained by this procedure. Even Athens was small compared to some villages or towns of today. This situation changed immediately when it became possible to mine coal and to transport it to fast growing human settlements. Narrow roads with higher buildings, dust and smoke in the air in addition to other sorts of pollution were one result of this development that took place at the beginning of the industrial revolution. Until this era, only few people would waste their time on thoughts about light and lighting. However, the advent of the industrial age was accompanied by some mysterious diseases such as rickets, the reason of which a Polish doctor discovered at the beginning of the 19th century, a "disease of darkness". The relationship between vitamin D and sunlight and vitamin D deficiency in patients with rickets were studied for about a century before people were convinced that the effect was caused by ultraviolet radiation.

In 1903, Niels Finsen, the father of modern scientific phototherapy, was awarded the Nobel Prize in medicine or physiology for his "Finsen light therapy" for infectious diseases, especially lupus vulgaris. Finsen did not distinguish between light and radiation. He always worshipped the sun because he said he needed the light himself. Niels Finsen came from Iceland, a country with a geographical location similar to those countries where people experience a reduced quality of life during some months of the year and suffer from SAD or Seasonal Affective Disorders.

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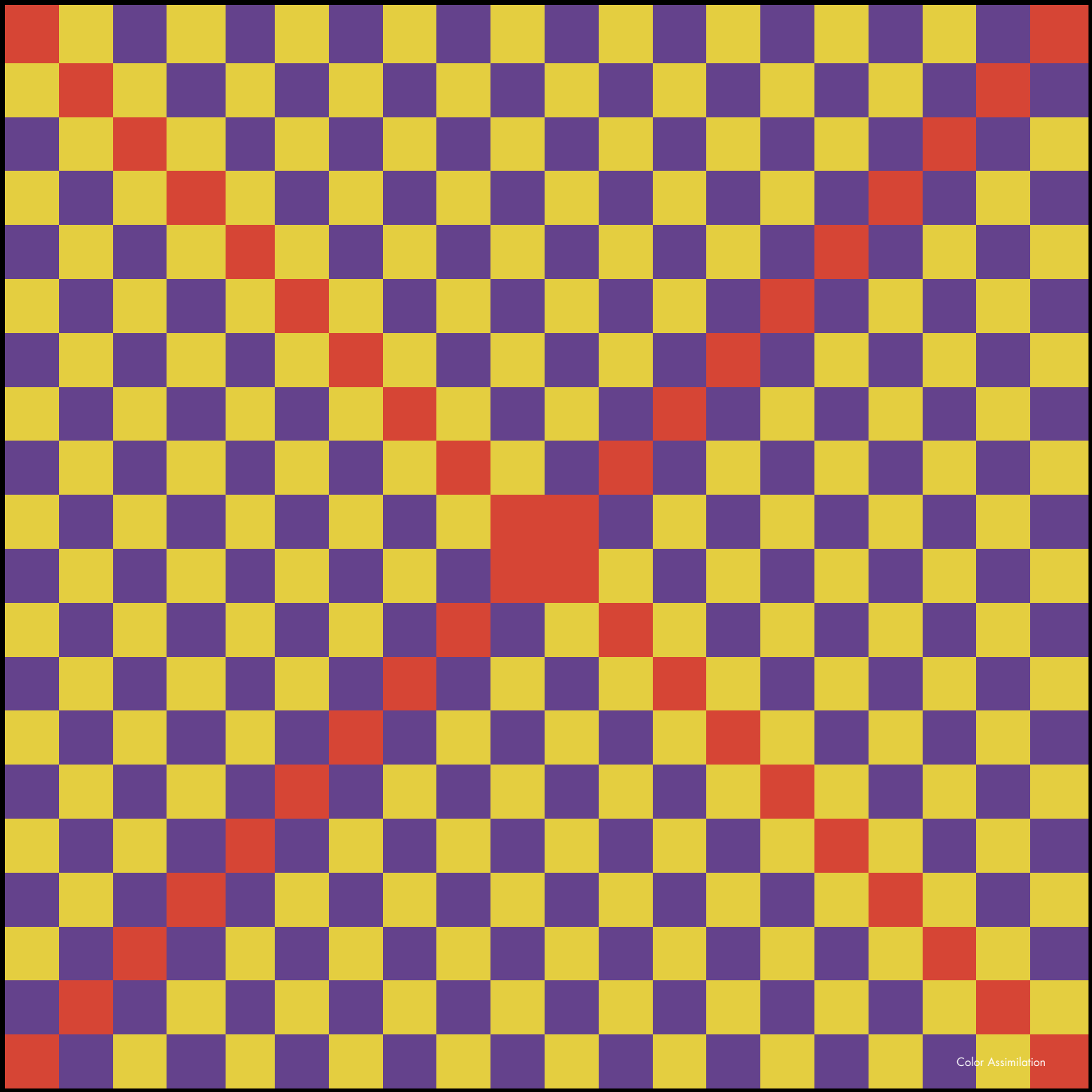
www.architectstudent.net/library/medical_aspects_of_lighting


Color Assimilation

The Joy of Visual Perception

Web book by Peter K. Kaiser, York University, Canada

Key words

How to prepare for a school project, glossary, fun things in vision, master diagram of the eye, visual acuity, visual sensitivity, color/color vision, measuring spectral sensitivity, distance perception, shape constancy, spatial frequency adaptation, adapting to darkness, motion perception, physics of the visual stimulus, fourier analysis; basics, point & line spread functions, some basic neurophysiology, eye cross section, neurons, retina, receptors, receptive fields, phototherapy, physiological response to color, interesting links connect you to perception relevant home pages, subject index, references, suggested readings in visual perception.

Introduction

This web book is not a book in the traditional sense. Most books are text supplemented by figures. This book is primarily figures and diagrams supplemented by text.

The purpose of the book is to stimulate interest about your sense of vision and encourage you to find out more about visual perception; perhaps to take courses on this subject at whatever educational institutions are available to you.

Although the main focus of this book is human color vision, many allied topics are covered, mainly because color vision does not exist in a vacuum.

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Find the complete material on the Web.

www.architectstudent.net/library/the_joy_of_visual_perception

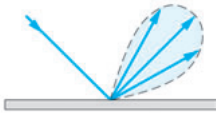
Light Measurement Handbook

Web book by Alex Ryer, International Light, US

Specular

Diffuse

Spread



Key words

What is light?
Electromagnetic wave theory, ultraviolet light, visible light, infrared light

The power of light
Quantum theory, radiometric power, photometric power, effective irradiance

How light behaves
Reflection, transmission, refraction, diffraction and interference

Manipulating light
Diffusion and collimation, transmission and focusing, lenses, reflection and reflective focus, spectral filtering

Light sources
Blackbodies, incandescence, luminescence, sunlight

Principles of light measurement
Inverse square law, point source approximation, cosine law, lambertian surfaces

Measurement geometries
Flux irradiance and illuminance, radiance and luminance, intensity, converting between geometries

Setting up an optical bench
Baffles, kinematic mounts

Graphing data
Line sources, polar spatial plots, log spectral plots, diabatie transmission plots

Choosing a detector
Silicon photodiodes, vacuum photodiodes, multi-junction thermopiles

Choosing a filter
Thin film interference filters, absorption filters, typical applications

Choosing input optics
Cosine corrected optics, radiance optics, special purpose input optics

Choosing a radiometer
Dynamic range, current amplification, transimpedance amplification, features

Calibrations
NIST traceability

References

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Find the complete material on the Web.

www.architectstudent.net/light_measurement_handbook

Lighting Design Glossary

Web glossary by Georg Mischler, Germany

Introduction

This glossary combines terms that are used in architectural lighting design and lighting simulation. The interdisciplinary nature of the work of the lighting designer is reflected in terms originating in architecture, radiometry, photometry, colorimetry, metereology, physiology, psychology, mathematics, geometry and computer graphics.

Examples from the glossary

Adaptation is the process by which the visual system changes its sensitivity, depending on the luminances prevailing in the visual field. The system becomes accustomed to processing higher or lower light levels in it's environment than it was exposed to before.

Daylight encompasses all natural light that is available during the day and originates from the radiation of the sun in the visible spectrum.

Daylight factor, the ratio of interior illuminance at a given point on a given plane (usually the workplane) to the exterior illuminance (reference) under known overcast sky conditions, eg. the CIE overcast sky distribution. This is one of the key values when analyzing the quantitative aspects of daylighting.

Daylighting means all measures that influence the input and use of natural daylight, be it the diffuse light off the clear or overcast sky or the directed light of the sun, into built spaces. Daylighting is influenced by the general structure of a building, the design of facades, windows and skylights, and can be further extended by the use of special devices for redirecting or transporting light.

Glare is an interference with visual perception caused by an uncomfortably bright light source or reflection; a form of visual noise. In its simplest form, glare is a consequence of the normally helpful capability of the human eye to adapt to different light levels.

Ground light is daylight that is reflected by surfaces below the observer (mathematically: below the plane of the horizon).

Illuminance is the total amount of visible light illuminating (incident upon) a point on a surface from all directions above the surface. This "surface" can be a physical surface or an imaginary plane. Standard unit for illuminance is Lux (lx) which is lumens per square meter (lm/m^2).

Perception, a meaningful impression obtained through the senses and apprehended by the mind.

Reflectance is the ratio of incident luminous flux upon a surface, which is reradiated in the visual spectrum.

Sky light is the part of the daylight that is scattered and redirected by the atmosphere. It can be available together with sunlight, or alone (eg. on cloudy or overcast sky conditions).

Sunlight is the part of daylight that is radiated directly from the sun to the area of interest.

Workplane, an imaginary horizontal plane situated at the nominal working height in an interior space. All illuminance and daylight factor measurements and calculations are made for points on this plane.

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Find the complete material on the Web.

www.architectstudent.net/library/lighting_design_glossary

VELUX - Our Work with Daylight

For almost 60 years VELUX has assisted in creating better living environments worldwide by providing daylight and fresh air. In 1942, Villum Kann Rasmussen invented the first modern roof window and paved the way for optimum utilisation of space under the sloping roof.

Innovative thinking, experimentation, and constant product development have ensured the continuous development of our roof windows and the relevant accessories for individual regulation of the amount of light, heat, and natural ventilation in a room.

It is important to be able to control the indoor climate – to keep the heat out in summer and save energy in winter. And it is important to be able to control the amount of light entering a room and ensure privacy when it is needed. People's need for daylighting and sunlight varies significantly depending on geographical and climatic conditions. The sun's rays through a window can be regarded as a blessing or a nuisance depending on where, when, and how the light comes in.

New possibilities

Daylight plays a determining role in how we perceive and use our buildings, and the rapid development of new types of glass with improved U-values has brought new possibilities and new challenges for architects, who now have far greater freedom of design, including the freedom to use more and larger windows. However, that also increases the risk of indoor climate problems, including overheating, and it is therefore becoming increasingly important for architects to focus on these aspects from the very start of the design phase. We know that daylight is of vital importance to our well-being. It affects us as human beings far more than we ourselves are aware of. We can define and measure the quantity of daylight with great precision, but when it comes to defining how the quality of daylight is perceived and how it affects us, our knowledge and methods come to short.

The Daylight Laboratory

VELUX supports and promotes daylight-aware building design that is focused on the users' demand for high visual quality and daylight comfort at the workplace and in the home. It is important to support the research concerning the impact of daylight and windows on the visual environment and our well-being, and VELUX therefore monitors developments in these areas closely.

The Danish Building Research Institute's Daylight Laboratory was established in 1998 with the help of funds from the Villum Kann Rasmussen Foundation, which supports science and other purposes for the public good. The Foundation's funds derive from the VELUX Group.

www.VELUX.com (professionals_architects lounge_reflections)