

In a modern building daylight can provide most of our lighting needs for the vast majority of the working day. It is therefore unnecessary to spend too much time in designing artificial lighting systems.

## **Introduction**

It is a common fact that people instinctively prefer natural light than to artificial light. This is usually due to the calming effects and the clarity it offers to which artificial light does not. Also, due to the rising energy costs and today's climate change concerns, using energy efficiently is now regarded to being financially sensible and now expected within the design on the building.

However it is difficult to justify the cost for the considerable design of day lighting on the basis of energy saving alone.

Here I will review and consider the impact that day lighting, also referred to as "natural" or "true light", has on the human psyche, the health impacts, benefits and problems both daylight and artificial lighting may cause and in general, whether due to modern buildings now incorporating daylight as a standard factor whether it is necessary to spend a great deal of time in designing artificial lighting systems. These impacts are reviewed in this paper for buildings that are generally used for offices, retail and other large buildings. Daylight effects in housing have not been considered.

## **Background history**

At the beginning of the 20<sup>th</sup> century, daylight was the principal light source in buildings, the artificial lights were merely used to enhance the readily available natural light. However within the short span of 30 years, by the 1940's electric lighting had altered the working environment by meeting the majority or in some circumstances all of the occupants' lighting requirements. During this period there have been continuous developments in the efficiency and types of lamps available. Artificial lighting is today used to provide lighting for the hours of darkness and also to provide visual affects to the interior and now becoming more popular, the exterior of a building.

Until recent years, energy efficiency has been a relatively low priority and low perceived opportunity to building owners and investors. However, these days' with the dramatic increase and awareness of energy and environmental concerns, Highlighted issues like global warming and reducing carbon footprints for instance have made natural day lighting a rediscovered aspect of building lighting design.

The actual physics of day lighting has not changed since its original use, however the building design to employ it has. Day lighting is often integrated into a building as an architectural statement and for energy savings. However, benefits from day lighting extend beyond architecture and energy. The psychological and physiological aspects of natural light on a person should also be considered. The comforting space and connection to the environment made available to building occupants provide benefits as significant as the energy savings to building owners and managers.

Although through many general studies state publicly that natural day lighting has calming affects there can be no guarantee that daylight will be successful in getting the full benefit of visual performance to the occupiers. Daylight can also cause distress and discomfort through glare and disruption, however this may also apply if the artificial lighting has not been installed correctly and not designed in a constructive approach, these distress and discomforts may also be formed.

## Impacts of lighting

It is obvious that some form of lighting is required in a building, otherwise productivity would be difficult for the work staff, children in a school or medical workers where lighting can be as important as life or death.

The Melbourne government have performed many studies into lighting and the effects of the human body, with the information they gathered Melbourne's new office building, known as Council House Two (CH<sub>2</sub>) was constructed. The following is a statement from their website "Light is essential for maintaining human biological rhythms during work, play and sleep. It adds to our sense of wellbeing, mental health and vitality. Majority of people spend a significant amount of waking time inside artificially lit buildings. We also work to 'mechanical time', which is often unrelated to our body's real needs. The alternative is to work in a well-lit office space, one that balances natural and artificial light and is not only desirable and aesthetically appealing but can improve staff health, efficiency and productivity". ([www.melbourne.vic.gov.au](http://www.melbourne.vic.gov.au))

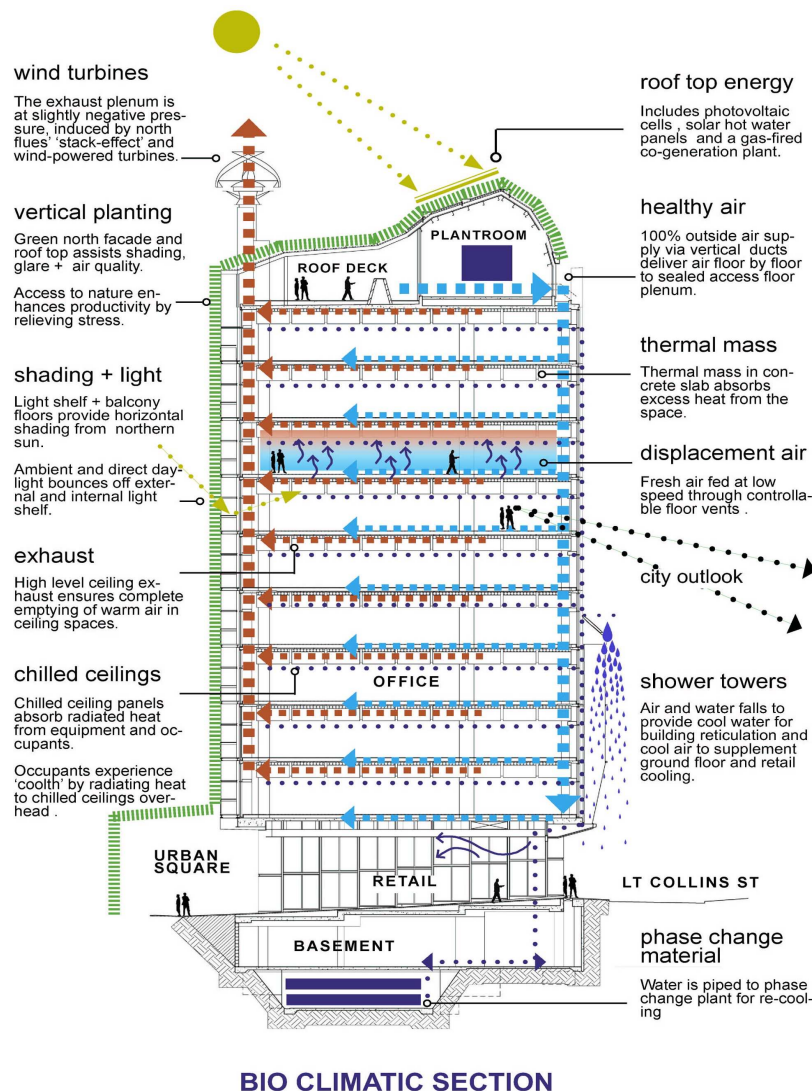


Fig 1. a well considered building design, Melbourne's new office building, known as Council House Two (CH<sub>2</sub>) incorporating major use of day lighting and ventilation. Both economically and environmentally friendly

## “Natural” Day lighting

Day lighting or natural lighting is admitted into a building by means of openings, whether it is a light shaft, windows or roof light which incorporates glass or an alternative material which is transparent enough to let the light shine through. The amount of light that is received through the building is generally only a small fraction that is shown outside, this is usually down to the size and the positioning of the viewing hole / openings, whilst other factors that may restrict the daylight entering into the interior of the building are other buildings usually higher than the one the user is in, tall trees and of course the effect of the British weather which is generally inconsistent and unpredictable at times. Methods can also be made to ensure that the occupants receive as much daylight as possible by placing workstations or machinery within a 6 - 7 meter radius of the windows while the added use of low-level cabinets and shelving will allow natural light into the building to be maximized.

The percentage of light which has eventually overcome all the above aspects are known as the daylight factor. This is a very common and easy to use measure for that particular daylight quality in a room. It describes the ratio of outside luminance over inside luminance, expressed in a per cent. The higher the daylight factor, the more natural light is available in the room. As stated on the website learn London.  
([www.learn.londonmet.ac.uk/packages](http://www.learn.londonmet.ac.uk/packages))

The rooms in which day lighting is most important should be allocated the preferred positions and orientations, remembering that it is more difficult to screen the low angle sun received on East and West face and that this is where glare and overheating are most likely to occur.

The luminance values and distribution required by the activities in each room must be established. In some spaces uniform lighting is required, in others some variety is desirable. In spaces where people occupy fixed positions like an office plan or a classroom for example, design criteria will have to be more stringent than for rooms where people are free to move in and out of a patch of sunlight, towards or away from a window when the sky clouds over.

Below is a table showing the required lux value for each room, lux is the unit of luminance in the International System of Units. It is defined in terms of lumens per meter . It is equal to the illumination of a surface one meter away from a single candle.

Corridors / Toilets	100-150 lux
Restaurant / Canteen	200
Library / Classroom	300
General office	500
Workbench	500
Drawing office	500-750
High-precision tasks	1500

Table 1 : Typical recommended luminance. ([www.erg.ucd.ie/mb\\_daylighting\\_in\\_buildings](http://www.erg.ucd.ie/mb_daylighting_in_buildings))

The major attribute natural lighting has above artificial lighting is energy consumption and the cost to power these lights. Nearly every commercial building is a potential energy saving project, where the electric lighting systems can be designed to be dimmed with the availability of daylight. Artificial lighting consumes more electric energy than any other building end-use, accounting for a third of all electricity consumed for commercial use. Ironically as previously stated, the majority of the lighting energy is consumed during peak daylight hours when the sunlight is readily available. Natural daylighting therefore has superior cost benefits of artificial lighting, with up to 75% of lighting energy consumption can be saved ([www.businessballs.com](http://www.businessballs.com))

### **Effects of lighting on the human psyche and the health impacts.**

A recent study indicates that typical people are exposed to total daylight levels of greater than 2000 lux for only 90 minutes each day, the loss of this connection can contribute to fatigue, insomnia, and SAD which will be discussed.

Different forms of lighting and electric lighting can change and affect the mood of people working in that environment. There is no doubt that people often prefer natural lighting than artificial light which many studies show and also on a personal level that sunlight enhances the mood. SAD (Seasonal Affective Disorder) is a type of depression that affects an estimated half a million people every winter between the months of September to April and in particular during the months of December, January and February.

SAD, an acronym for Seasonal Affective Disorder, is caused by a chemical imbalance due to the shortening of daylight hours and the lack of sunlight. For many people SAD is a seriously disabling illness, preventing the person from functioning normally without stable medical treatment. For the majority though, it is a mild but debilitating condition causing discomfort but not severe enough for diagnosis as a clinically recognized syndrome. This is known as subsyndromal SAD or more commonly known as 'the winter blues.' As found on the site Sada. (<http://www.sada.org.uk/whatis.htm>)

The most common method of admitting daylight into a building is through the use of glass windows. Glass windows are able to provide daylight, sunlight, ventilation and welcomed noise into the occupied space. Windows also provide the person with a view, however whether it is a pleasant view is another factor, out from the occupied space. The two most important attributes regarded for windows are the view and the amount of access of daylight they are able to allow into the building. The popular reason for a view is due to people wishing to have visual contact with the exterior and be aware of the changes in the weather and other activities. Another benefit of a view is to exercise the occupier's eyes more, due to the adjustment in focal length when looking outside. This can reduce eye strain, a common complaint for workers viewing computer screens for long periods. An alternative explanation as to why natural light is so preferred is due to such a negative perception people have of artificial lighting, therefore windows are always favoured.

Generally it is also felt that working by natural light results in less discomfort and stress, not due to the reason that natural light has been proven to be more beneficial to the body in any way, other than that working with artificial lighting alone was damaging to health, specifically when exposed to the lighting conditions for a long period of time.

## Artificial Electric lighting

The requirement of natural light has been traditionally unquestioned (Mitchell) Natural lighting is associated with some severe disadvantages. The depth to which natural light can penetrate the room is limited, so this limits the depth of buildings lit in this way creating long external walls and limited use of restricted areas.

Mitchell's also state that the negative aspects for the sole use of natural lighting in a building are the amount glazing that is required to provide the sunlight. Glass makes a significant contribution to heat loss as it presents a cold surface on the interior of the building and is possible it may be subject to condensation. To help prevent this, double glazing and adequate ventilation would be required and to be installed throughout. Whilst in the summer and hotter months, the heat of the sun may give rise to heat gain and may overheat the building causing suffering to the occupants, during the evening the building may loose the heat gained during the day.

It is possible to use these features as beneficial aspects when in the design build process of the building; however these elements do not come cheap. A more than common procedure to overcome the uncomfortable heat caused by solar gain is to install air conditioning and air handling units for the larger building. These units require a vast amount of interior and exterior space and are also powered by electricity requiring a large quantity of power. The use of air conditioning may also defeat the object of designing the building for the purpose of not using artificial lighting systems for cost saving and environmental grounds.



Sky glare through the large open windows make it extremely difficult to concentrate and work.

Sky glare is another issue with the result of incorporate large windows into the building design. The glare may result from direct sunlight or reflected from other buildings or vehicles, this can severely affect vision and is possible that accidents may occur if the user is in constant use of machinery. In case of this, special controls and additional measures will be required for prevention, it is a common procedure for the installation of sun shades or blinds for example to be a requirement. However it is important that the occupiers are able to operate blinds to suit their preferences and that the shades or blinds are not to remain closed at all times, this could lead to a significant reduction in the benefits of daylight penetration under favourable conditions.

A mistaken belief is that solar shading is only for use of the summer months. Whilst this may be true in respect of heat gain, glare is noticeably worse in winter months, since the sun is much lower in the sky, and will penetrate far deeper into a room.



Additional measures of installing blinds are required for prevention against glare

Visual display units or commonly known as computer screens or monitors, are a common sight in today's office, schools, hospitals and in many types of buildings. VDU's present a lighting issue of producing a mirror-like reflection in front of the user. During the day with sufficient day light or artificial light this would not cause a significant problem, however glare would cause a problem is the user sits directly in front of the window or lamp or the reflection is the user is facing away from it. When designing a room for computer users consideration should be given to down lighters or luminaries with smaller directional

However it may be believed that as a result of these disadvantages, artificial lighting also referred in this paper as electric lighting, would be used quite frequently to the exclusion of daylight. In the design of modern buildings it cannot automatically be assumed that windows are required as standard, many buildings are not situated in a location where sunlight is available for the majority of the working day.

In relation to electric lighting it will be necessary to determine what part the lightning in

the building will play. By night, artificial lighting will be the sole illumination, natural light of the moon will not be enough for general working conditions, and this would cause disruptions to work during the periods where the availability of daylight is shorter or evening overtime or shifts that are required to beat crucial deadlines.

During the day, artificial lighting will also be required and may in some circumstances be the sole source of illumination where that section of the building is windowless, a basement for example will require 100 per cent artificial lighting where no natural day lighting would be able to penetrate the interior. It is however possible to install light wells or light shafts which may be able to draw the exterior day light in to the room, however this will not be able to provide sufficient light to exclude artificial lighting in its entirety. As well as providing overall illumination in a way which can be similar to natural lighting (technology today is improving, but the quest for artificial "natural" lighting is still ongoing) electric lighting is today commonly used for dramatic effects, to produce contrast and ambience. This is commonly used in museums, galleries and more commonly retail stores where artificial lighting is used to enhance the works or items on display.

Office during the evening, natural daylight is not available therefore having to rely on the artificial lighting to enable work to continue.

Electric lighting is also frequently used to provide emergency lighting in case of fire or another catastrophe that may occur, the lighting is required to guide the user out of the building, it is also used for security purposes at night to assist with illuminating locations of the building at risk or to prevent unwelcome guests from getting into or out of the building undetected.

## **Conclusion**

The major drawback for the use of natural lighting is its unpredictability and its absolute unavailability at the evening whilst artificial lighting can be readily available permitting there are no issues regarding the electricity supply.

The psychological analysis of natural day light is a very positive notion and would be difficult to convince otherwise, along with the view and the effective stimulant to the visual system it offers whilst the sole use of artificial lighting in a building produces negative feedback. However, with the glare and no actual guarantee that daylight will be successful in maximising visual performance, people will take action to reduce or eliminate daylight with shades or blinds if the glare is causing discomfort or increases difficulty in completing the tasks at hand.

With the installation and managing of artificial lighting many high expense factors are



concerned, whilst the complimentary natural light is available for the majority of the working day it, could be stated within the question that it is therefore unnecessary to spend too much time in designing artificial lighting systems. However I feel that natural light and artificial light could in fact compliment each other, by providing an acceptable balance between the two. Artificial auxiliary lighting would be applicable in situations where natural light is unavailable and where artificial lighting is able to enhance the visual appearance and combine the required amount of light to assist the occupier with allowing the required work to continue and not relying on the irregular weather.

With regards to the design of lighting in a modern building, the intension is to achieve the required or appropriate lux value for that room. It is proven that a vast amount of design is required in the install of this complex lighting system as with the installation of any service, the shape (depth / height) of the room, colours to enhance the light and directions of the lamps to prevent glare determines the aspect that are essential even if the requirement is to install the artificial lighting as just a supplementary system. It is therefore my conclusion that even with the amount of daylight we be capable of achieving in the United Kingdom can in fact provide most of our lighting requirements for the vast majority of the working day, I do conclude that it is undoubtedly necessary to spend the required time, money and research in designing and installing adequate artificial lighting systems specifically as an auxiliary lighting system, to gain the benefits of a productive workforce.

Word Count 3,138.

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