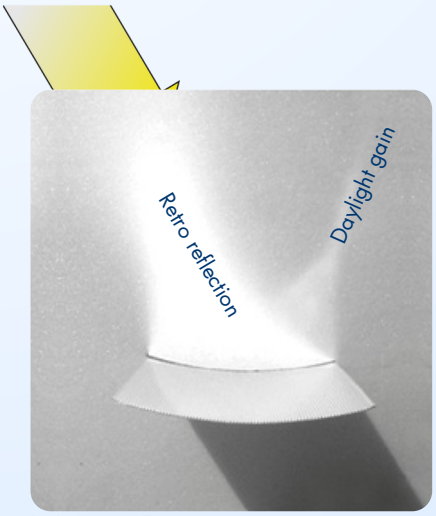
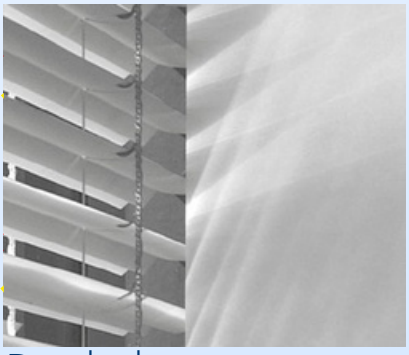
Less Heat
More Light

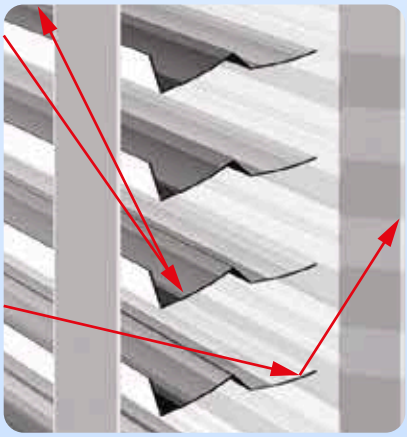
RETRO SOLAR



Heat Protection



Daylight



Glare Protection










Projects

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PREFACE:

Natural daylight is extremely valuable for the human physiology. Unfortunately, most office buildings around the world are supplying only 500lx which must be considered as biological darkness with negative consequences for human health and energy waste for artificial lighting.

As specialist for daylight systems Dr.-Ing. Helmut Köster developed the optical mirror systems for our daylight blinds to solve the problems of overheating of buildings but still, simultaneously supplying sufficient light to significantly improve the daylight autonomy of offices together with an higher transparency and view through.

It is therefore a pleasure for us to interview Dr. Köster to reveal the scientific principles of daylight technology and to explain the angular selectivity of the mirror systems.

RETRO***Solar***
Kirn, May 2020

The interview has been published in the following magazines, some of them in abridged form:
xia, Intelligente Architektur, 04-06-2019
„Retrotechnik Sonnenschutz- und Tageslichtsysteme“
Gebäudehülle, 03.20 „Tageslicht intelligent nutzen“
GFF, Gebäude Fenster Fassade, 05.04.2020 „Wir haben den ewigen Kampf gewonnen“.
R+S Rolladen + Sonnenschutz, Ausgabe 5 2020
„Tageslichtumlenksysteme fördern das menschliche Wohlbefinden“.

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Daylight Redirection Systems

SAVE ELECTRICAL LIGHTING,
REDUCE CLIMATE LOADS
PROMOTE HEALTH AND WELL-BEING.

Dr.-Ing. Helmut Köster, specialist for the development and planning of daylight systems, explains in an interview the advantages and perspectives in the architectural implementation of an improved use of daylight with the focus on the theory of light control by means of mirror systems and the effects on health, energy and CO_2 savings.

The development office Köster Lichtplanung has accompanied the implementation of more than 600,000 m² of daylight control in glass roofs and facades worldwide. Dr. Köster holds over 100 patents in the field of lighting technology and is the author of numerous publications and books published by Birkhäuser and Witag as well as a frequently requested speaker at universities and chambers of architects.

Licensees are mainly blind producers. RETRO*Solar* has specialized in the production of Dr. Köster's daylight guidance systems, as far as those are based on optical mirror systems.

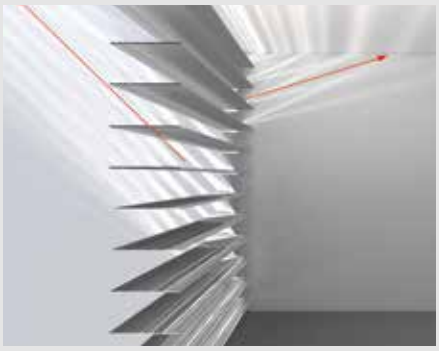
Some questions to him on the subject of daylight control:

Why redirecting daylight?
Daylight redirection allows to effectively illuminate interiors at greater depths using mirrors or prisms and/or to protect interiors from overheating by redirecting sunlight back into the sky.

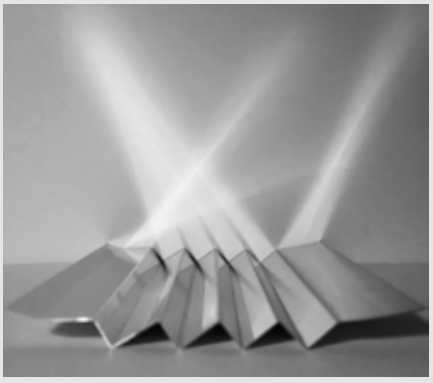
What is the difference against white louvers?
Even white louvers can be provided with a high reflectivity. However, a white louver reflects diffusely, i.e. the light is scattered randomly and evenly. Part of the reflected light is directed inwards, part outwards and a large portion is directed to the underside of the upper louver where it either causes glare to the interior user due to high brightness or - if the underside is darker in color - the light is being absorbed and thus converted into heat. The interior heats up.

Which are the improvements by retro technology?
Retro technology uses mirror surfaces shaped with high precision and following the laws of mirror optics (angle of incidence = angle of reflection). By means of a special louver contour, the sun is either directed back into the sky and/or towards the interior ceiling and into the room depth. This enables an exact determination of the g-values, the light transmission values the view through and the daylight autonomy in the interior!

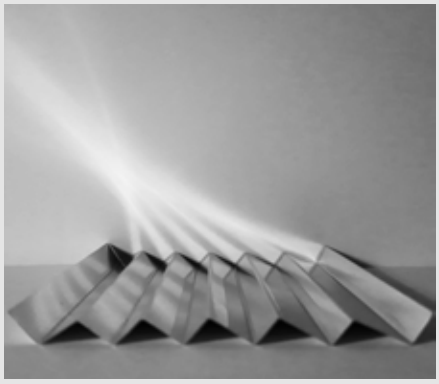
A white, closed blind directs the energy to outside also!
Right! But the view through is prevented if the curtain is closed and the interior is darkened. The lights are switched on even though the sun is shining outside. What a counterproductive building technique!



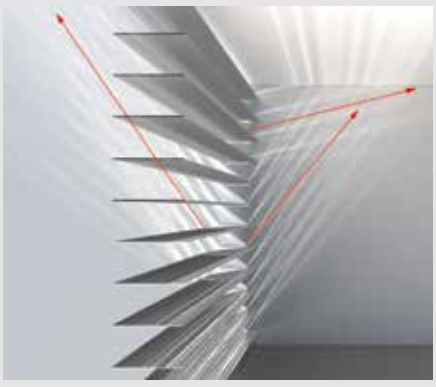
Strategic light redirection during high sun in summer: protection against overheating, daylight illumination.



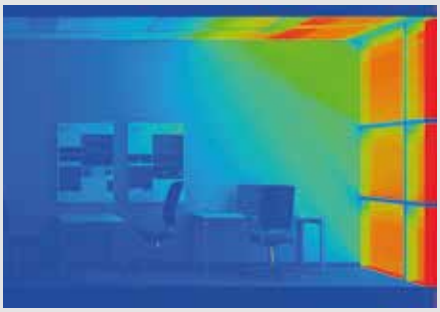
Bifocal light redirecting louver to protect against overheating and for a targeted room depth illumination with zenith light.



Monofocal light deflecting louver by Fresnel optics, external focal point. Sun protection with horizontal louver position.



Light redirection during low sun irradiation in winter: Optimised view, glare-free workplace.



Visualization: Uni Luzern, Lars Grohe

- unnecessary energy consumption for lighting and additional heating by internal light sources!

Isn't it necessary to close the louvers to protect the interior from overheating?

No, the louvers are calculated to reflect the sun in a horizontal, open position. This is achieved by stepping the louver contour. To be precise: The louver contour forms a Fresnel mirror similar to a fragmented parabola. The Fresnell reflector has its focal point to outside! The light is redirected without closing the louvers. Therefore, the diffuse daylight can transmit through the open louvers and they still protect from direct sun. A darkening of the interior is avoided. The user has a perfect view to outside and the optical communication with the building environment through the open blinds is optimally secured.

But once the sun has transmitted to inside...?

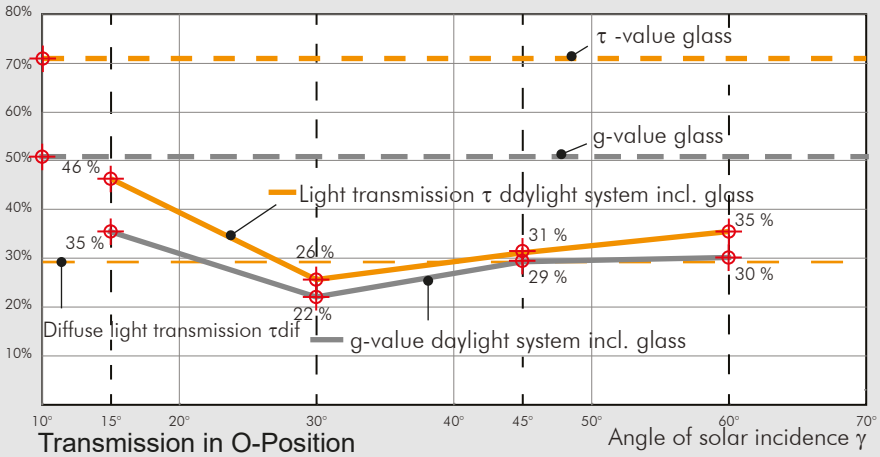
Sunlight is short-wave radiation without long-wave heat components in the radiation spectrum. Space has -275°C! A heating happens only by energy conversion of short-wave radiation into long-wave radiation, i.e. by absorption. The intelligence of daylight redirection systems is to reflect the sun back into the sky without absorbing the solar radiation. This is achieved through mirrors by the very specific louver geometries with mirror-like surfaces, which ensures that the sun is reflected back outwards with a single reflection without energy transformation in heat. Keyword: Monoreflectivity.

Which g-values do you realize?

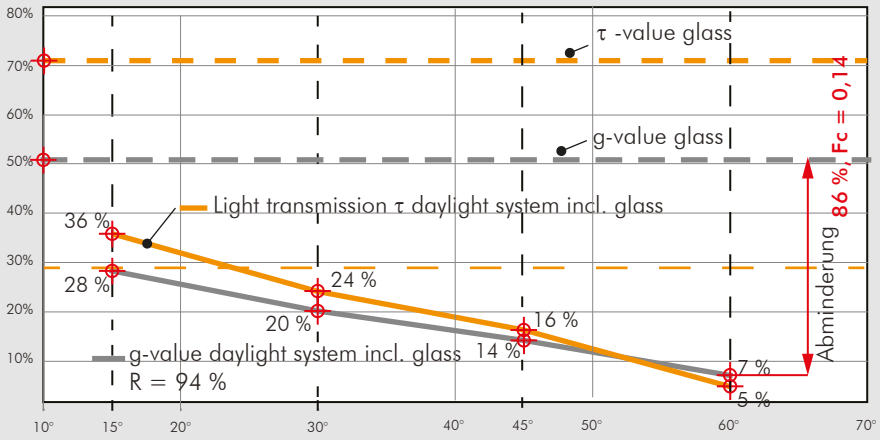
This primarily depends on the external glazing and the position of the louvers, e.g. in a closed cavity of insulating glass and a surface reflection of 96% of the louvers, gtot-values between 0.05 and 0.07 can be achieved even without a solar protection layer on the outer glazing. If the blinds are installed interior behind a colour-neutral solar protec

The precision of the optical mirrors delivers precise results:

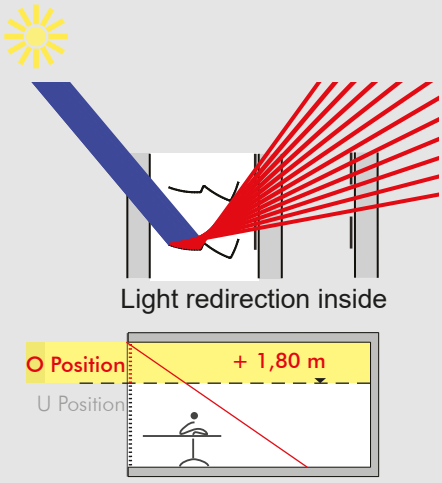
g-values with heat protection glass, low-e on pos. 3 and 5 with horizontal, open louver adjustment and simultaneous visibility < 75%

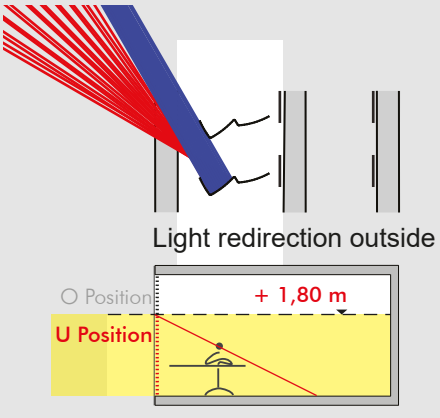


Transmission in O-Position



Transmission in U-Position





tion glass e.g. type 66/32, g values of 0.1 can be realized with open blinds and during high summer sun.

And how do you manage to illuminate the interior in great depths simultaneously?

I have developed the strategy of bifocal louvers. These have at least 2 sections: a first section that directs the incident sunlight outwards and a second section that directs the incident light inwards. Such dichometric slat structures can be used in the lower window area to completely block out the high summer sun. Diffuse light and low angles of the sun, however, are directed steeply and glare-free to the interior ceiling. In the upper hanging area, the slats are rotated by 180° around a vertical axis to redirect zenith light into the interior depth. This way, a blind curtain is given a complex functunality with two different functional zones, which however is easily to be controlled, as the louvers are calculated for maximum transparency in a horizontal louver position. The blinds only have to be closed for low angles of the sun < 30°.

Mirrors can glare, how do you avoid glare inside the building and in the environment?

With the help of our ray trace software we can calculate the direction of light deflection inwards or outwards for any angle of incidence of the sun. It is a high art to design and manufacture the reflectors so that the light is reflected back into the sky without to create glare in opposite buildings or on the street level. The light transmission in the lower window area is directed steeply onto the ceiling. In the upper window area above 1.80m daylight is deflected horizontally into the depth of the room to avoid glare in the human eye.

Is all this still theory or are already measured values from test institutes availble proving the effectivness of your daylight systems in real?

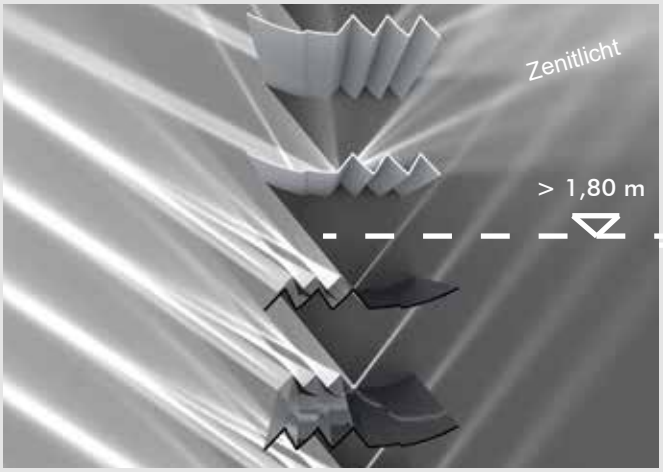
With simpler mirror geometries, we completed the first construction projects already in 1988/89. Here the light control systems were integrated into the insulating glass as fixed systems. Let me give you some examples of construction projects with retro louvers from my patents:

- 2,000 sqm roof glazing of the Audi pavilion in Ingolstadt
- Roof glazing of the plenary hall of the former Preussischer Landtag, Berlin
- Facade of the debis buildings at Potsdamer Platz by Lord Richard Rogers, Berlin

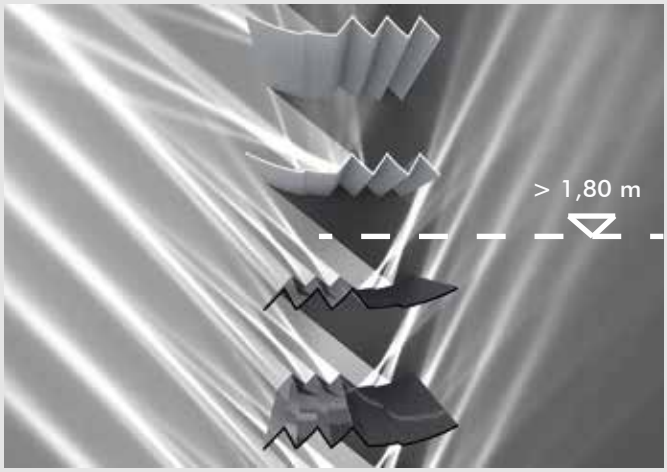
Since 2001, the company RETROSolar has been manufacturing further light control systems for insulating glass and interior blinds as well as external blinds. The company Schlotterer in Salzburg is manufacturing daylight venetian blinds with bifocal louver optics for external use since 2013. Let me name some well-known construction projects by RETROSolar:

- Blue-Win high-rise building in Zurich with approx. 3,000 sqm (RETRO*Flex* 80mm)
– Energy Tower in Linz, 3,000 sqm (RETRO*Flex* 80mm)
– Sopharma Litex Triple Towers in Sofia, approx. 10,000 sqm (RETRO*Flex* 80mm)
– Bank Santander in Sao Paolo, approx. 10,000 sqm (RETRO*Flex* 25mm)
– Allianz Versicherung in Sao Paolo, approx. 10,000 sqm (RETRO*Flex* 25mm)
– Stadtwerke Bochum, approx. 3,000 sqm (RETRO*Lux* 50mm)
– Central Bank of Kuwait, 2,500 sqm (RETRO*LuxTherm* 20mm)
– 1,500 sqm glass roof in Seoul (RETRO*LuxTherm* 12mm)
– Museum and office buildings in Beijing and Shenzhen for Baidu (RETRO*Lux* 50mm).

Further projects: Schweizerischer

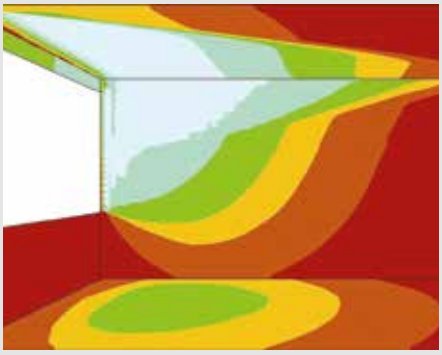


Light deflection at high sun position in summer to protect against overheating. Daylight illumination above 1.8m secured with zenith light.



Daylighting in winter: To avoid overheating and overillumination some sun is deflected outside, more daylight is flooded to the ceiling.

Rundfunk, Zürich, Bayerischer Rundfunk, Munich. France: several banks in Paris and Bordeaux have been equipeed with bifocal slats from RETROSolar.
I would like to emphasize that we were supported in the development by the DBU and the Federal Ministry of Economics, partly within the framework of joint research projects together with Fraunhofer Institutes and the TU-Berlin, which carried out the photometric and g-value measurements.



Daylight distribution in false colour presentation. Daylight autonomy up to 8mm room depth is possible.

Strategic lighting direction over the ceiling. Flat sunlight partially enters between the slats as a semi-shade zone without dazzling the user. The users appreciate the light experience in the interior.

The non protected window is creating glare.

projects, we have demonstrated a reduction in total energy consumption of up to 30% as a result of reduced cooling loads and significantly improved daylight autonomy. Artificial lighting accounts for approximately 30% of the total energy consumption of administrative buildings. We reduce this consumption by 50% and thus simultaneously reduce the cooling loads. The saving effects are much more significant compared to thermal insulation measures.

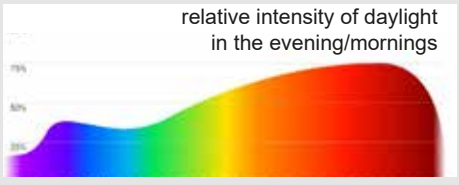
It seems you have a sunny future ahead of you!
Not only us - facade constructions will benefit because we have won the eternal battle against overheating of glass facades - especially the CC facades. We reduce the temperatures in the cavity and the temperature of the internal glazing. This brings thermal comfort. The simultaneous transparency and optimized daylight illumination increase visual comfort. Another winner is the energy balance and CO2 footprint of buildings. Based on completed construction

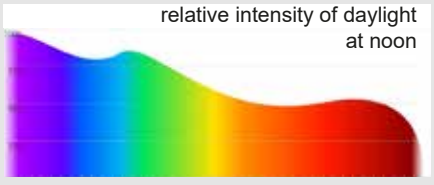
Doesn't it make more sense to shade the windows with photovoltaics?
The light is deflected inwards almost without loss and without great technical effort, while photovoltaics still have a comparatively modest efficiency. The cost/comparatively modest efficiency has. The cost/ Utility ratio of daylight use is incomparably much higher. Added to this is the experience value of daylight indoors and the positive effect of the natural daylight spectrum on the health of the users.

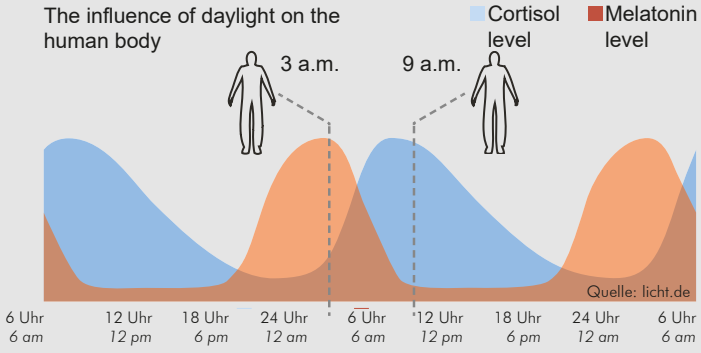
DAYLIGHT COSTS NOTHING, PROMOTES HEALTH AND IS ENJOYABLE. DIRECT LIGHT AND SHADE CORRECTLY!

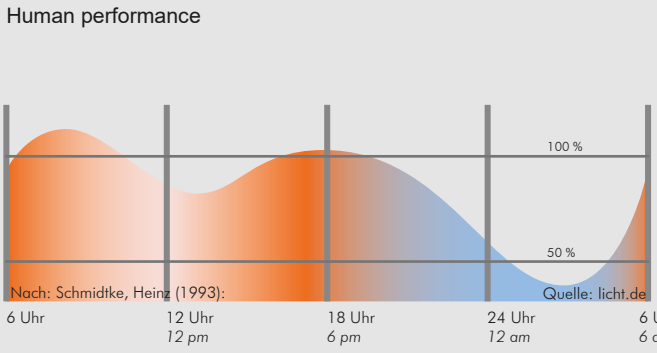
What are the health effects of a natural daylight supply in offices?
The human physiology has developed under daylight. Today we live in our buildings in biological darkness! The human physiology is triggered by the intensity and colour of the natural daylight spectrum. Keywords: circadian rhythm, melatonin and serotonin levels in the blood. Melatonin is a sleep hormone and is stimulated by high level of red spectrum. A higher blue component and an increased daylight intensity reduces melatonin and promotes the production of cortisol and serotonin. Serotonin is considered as a hormone supporting the experience of bliss.
With 500 lx at a workplace, nothing happens in human physiology. The workplace regulations and DIN standards only require illuminance levels for fulfilling visual tasks. Requirements for providing the physiology with sufficient daylight are laid down neither in the technical nor by the unions or occupational health guidelines.
Important photobiological processes in the human organism take place between 300 nm and 800 nm. UV radiation < 300 nm not only helps for vitamin D3 formation but also for killing bacteria.
85 % of all sensory perceptions are of optical origin. Light is therefore the mediator between environment and brain. For this communicative performance in the brain 25% of our energy budget is needed. Visual acuity decreases sharply with age. This can be partially compensated by brightness or illuminance levels. Therefore, natural, good daylight illumination is of particular importance.
"In our round-the-clock societies of the 21st century, we have developed habits that have been scientifically proven to be associated with illnesses such as diabetes, cardiovascular disorders, depression, eye diseases, lack of sleep, obesity, concentration difficulties and much more". (Dr. med. Ulli Bauhofer)

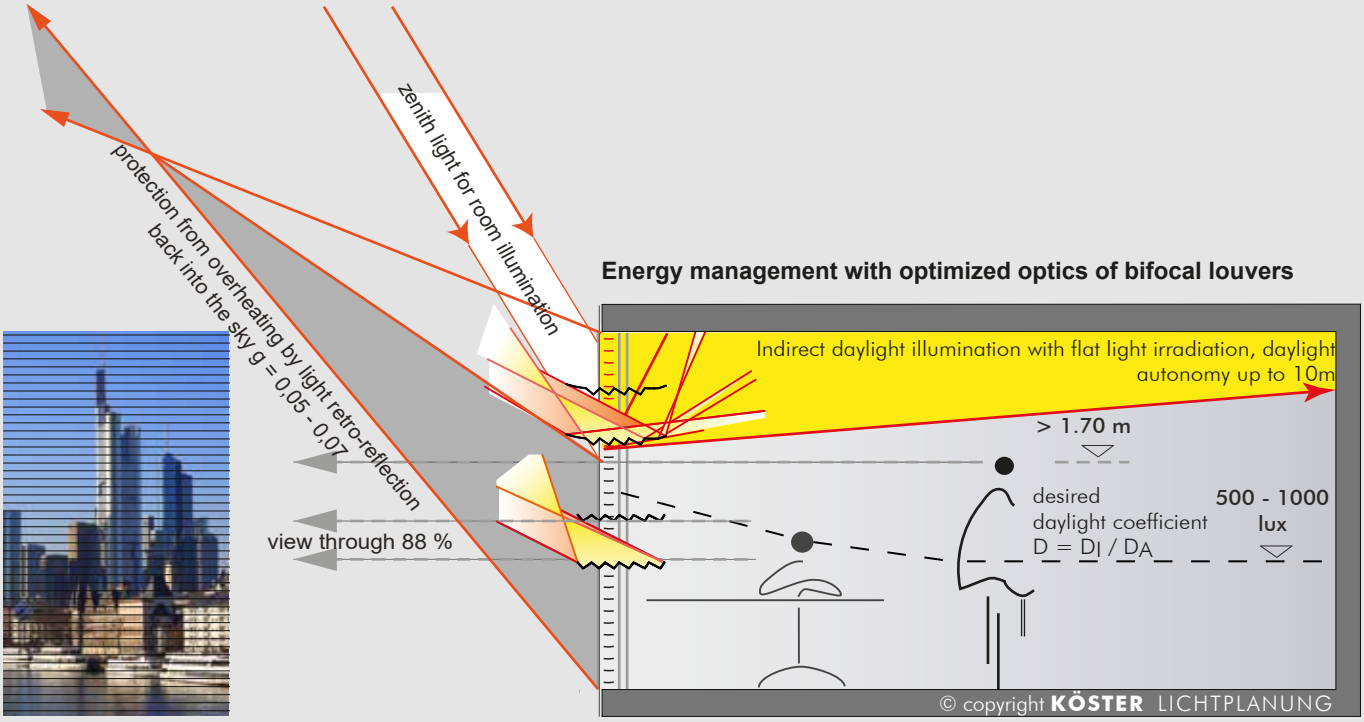
The lighting industry has already jumped on the bandwagon of stimulating the human circadian cycle by changing lighting intensity and luminous intensity.
Very good, but why with artificial light? 19% of the total energy demand of the world is due to artificial lighting! If we really want to save energy, we should use the natural resource daylight more responsibly instead of darkening the rooms by shadow devices and finally depending on artificial lighting.
The sizes of our glass facades are sufficient for a natural illumination of interiors even at great depths. However, this requires a system of light deflection that captures the zenith light and the diffuse sky and redirects them deep into the buildings.
Natural daylight offers a lot of stimulation: The sun constantly changes its position, its brightness, its light color. The cloudy sky also offers variations. We can bring this happening during the day into the interior by means of light-redirecting systems to make it experienceable for human pleasure and to stimulate the physiology and psychology.











Excellent view through

Principle of daylight guidance in the façade: The precision mirrors direct the sun into the depth of the interior above eye level. In the lower window area, the sun is retro-reflected even when the blinds are open.

Is there evidence for the health factor daylight, for example in the form of physiological measurements?

Oh yes - first of all I refer to studies on the duration of hospital stays depending on the daylight coefficient. There are comparative studies from California and South Korea, which show that the duration of stay of patients in rooms with south orientation and better daylight coefficient - depending on the medical department – are reduced up to 15%.

At the private medical university in Salzburg a double-blind study was conducted in a primary school. Here, in classrooms equipped with daylight venetian blinds type RETROLux A from the company Schlotterer in Adnet showed significant changes in the children after half a school year. Keywords: improved receptivity, less daytime tiredness, greater alertness, improved social behaviour, etc. Cause was a faster breakdown of melatonin in the morning hours and a significant increase in cortisol and serotonin levels due to brighter classrooms as a result of solar input via indirect daylight flooding via ceiling of the classroom.

Does an improved daylight illumination of the classrooms have an influence on the problem of myopia?

The WHO has declared myopia a pandemic. In Shanghai, 90% of children are short-sighted because they only sit indoors and stare at screens and mobile phones all the time.

According WHO up to 20% of children will go blind by the age of 30!

The only recognized remedy for myopia is intense daylight with high illuminance levels and the possibility for a distance view. That is why it is so important that we not only redirect the daylight but also ensure that the blinds are open, transparent. This brings us back to the louver geometries.

How do you manage to retro-reflect the overheating sun, to redirect diffuse daylight and at the same time enable the transparency of the daylight blinds?

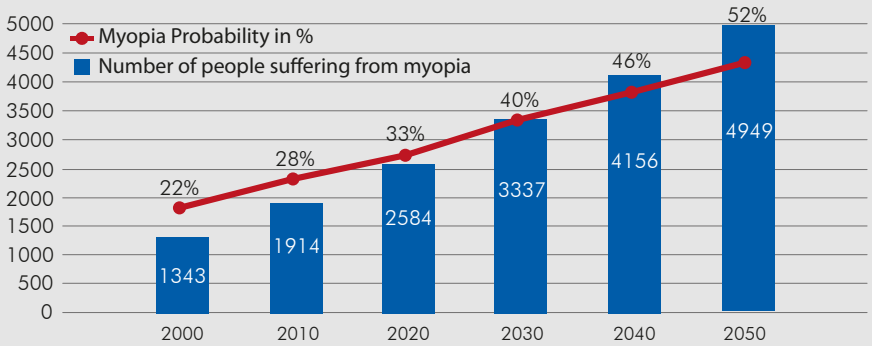
Take – for example - a look at the new RETROLux blinds. In the lower window area we retro-reflect the incident sun by means of a fresnel optics. The contour is calculated to reflect the sun as the louvers are adjusted horizontally - in other words, when the view through is at its best.

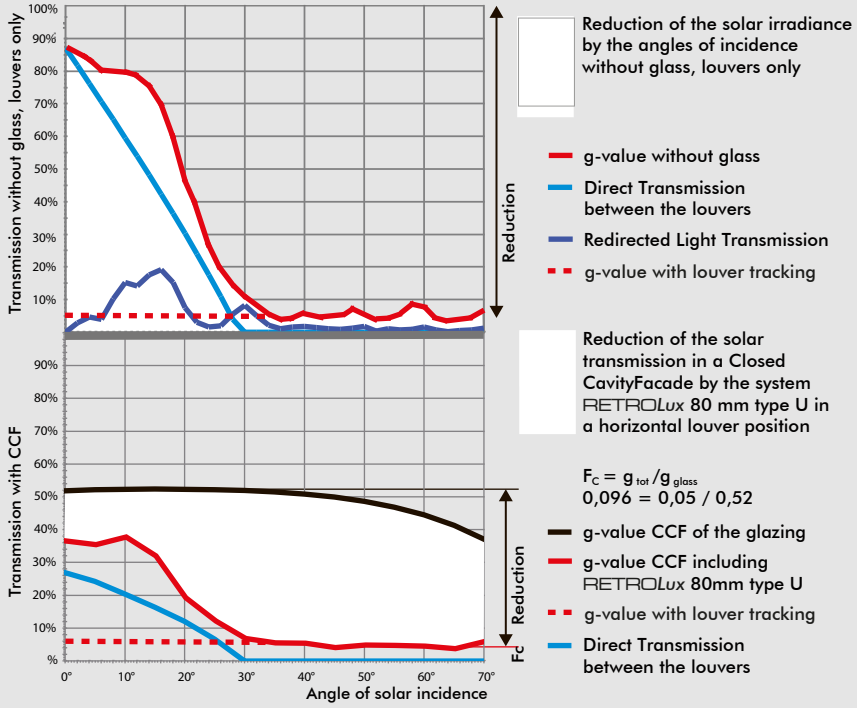
In the upper window areas, the louvers show small lightshelfs to gain zenith light and some direct sun for improved room illumination.

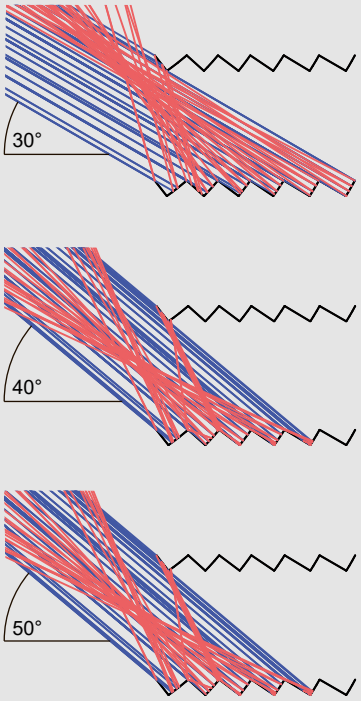
The light-shelfs balancing tasks of light transmission and light protection and improve daylight illumination but without to overheat. Therefore, part of the light is always deflected. Only the light shelfs in the upper window area causing a bifocal optic, the louvers in the lower area are monofocal to reflect the impinging sun.

Predicted increase in myopia in children as a result of inadequate daylight illumination.

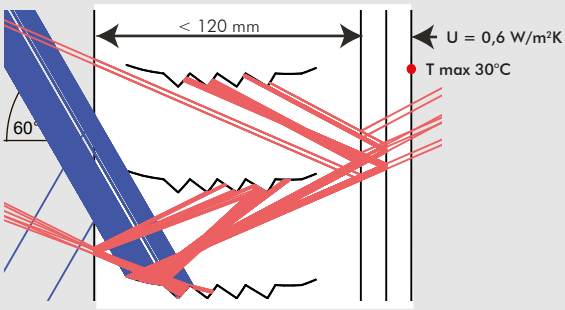
Source: WHO Report on Myopia, Brien Holden Vision Instiute.

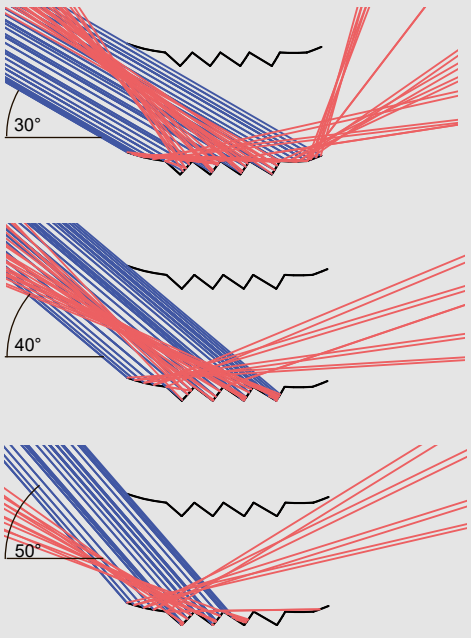






Raytracing in a CC Facade



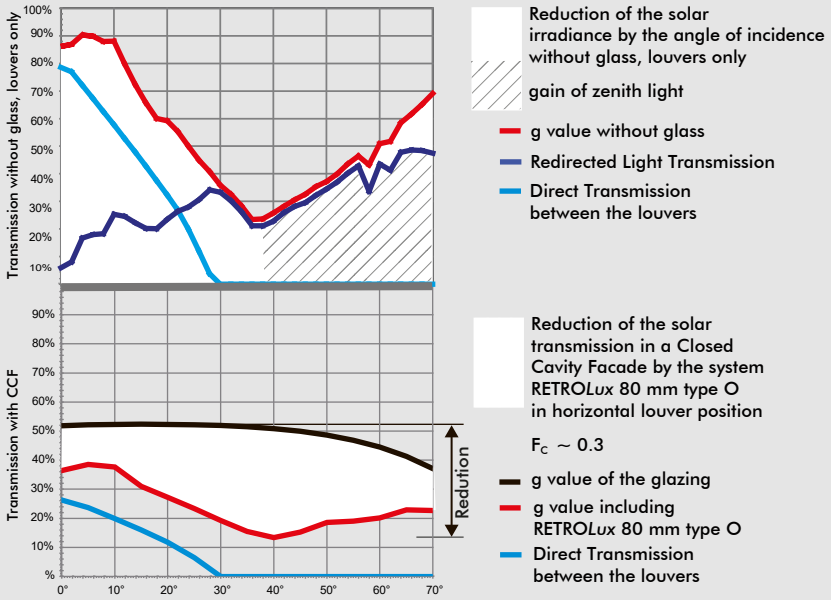


Sun incidence
Light redirection

Optical precision is the key:
RETROLux 80 mm

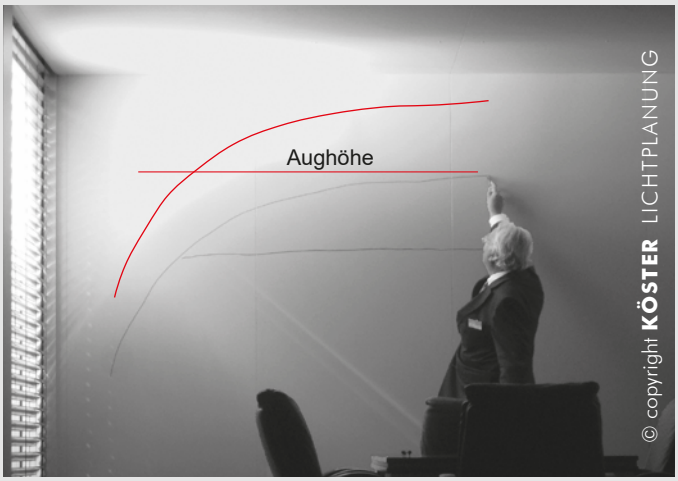
Monofocal light deflection type U: Incident light is deflected back into the sky with one single reflection, to achieve minimal g-values with horizontal louver adjustment, while at the same time ensuring excellent view through. Only during flat angles of incidence, the louver tilting has to be adjusted.

A ray tracing between the glass panes shows the mirroring on the glass surfaces. They are intercepted on the undersides of the louvers. The panes themselves are without glare.



Bifocal louvers RETROLux 80 mm type O have one focus outside and one focus inside. There are installed above 1.80 m within the blinds.

Improved daylighting prevents myopia in school-age children and supports the production of the happiness hormone serotonin (PMU double-blind study, Salzburg)



Directionally selective lighting for glare-free deep room illumination is only possible with optimised mirror louver contours.

And that's enought?
Under a clear sky, we measure approx. 1,000 W/m² of radiant power from the sun and illuminance levels around 100,000 lx. It is enough to harvest a few percent to illuminate interiors with 1,500 lx during the day!

Where do you see the daylight technology in 10 years?
I trust that in 10 years our society will have recognized the benefits of an improved daylight illumination. Daylight control blinds will be the new standard. The use of daylight is free of costs, promotes health and is an enjoyable experience. What more do you want?

However, this requires a major rethinking in the industry, which prefers to ignore such innovations in order to continue with their existing products and structures.
Correct, daylight is a disruptive technology that will overwhelm some companies that stick to their standards. The market will certainly teach some companies a lesson.

However, this will only succeed if you find fellow compaigners.
We rely on the intelligence of architects and specialist planners. We have developed a software to calculate the energy savings in terms of reduced cooling loads and reduced consumption of electric lighting. We calculate the CO2 savings and thus meet all requirements for a climate adapted designing. We prove a saving of 30% from the total energy demand of administration buildings by using an intelligent daylight technology. This is enough of the good cause to convince even building owners!

View through of RETROLux 50mm in working position of the blinds
Grundschule Luxembourg
Architekten: Witry & Witry SA

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Citizens' initiatives are forcing national governments and companies through the courts to do more for climate protection

STATE BUILDING AUTHORITIES AND EVEN COMPANIES MUST EXPECT CLIMATE PROTECTION LAWSUITS

In the "Zeit" No. 4 of 16 January 2020 is reported under the heading "On behalf of the climate, activists worldwide are suing national governments. Their goal: better environmental governance." The fact that not only in Germany, but worldwide, environmental activists are increasingly seeking to take legal action in order to force governments and companies to do more to protect the climate is demonstrated by some 1,300 lawsuits pending in courts worldwide.

Such lawsuits can be successful if the governments or companies sued lose and could thus be forced to increase their environmental commitment. The lawsuits are based on the fact that emissions of greenhouse gases violate human rights.

Example Netherlands: Dez 2019, the Dutch Supreme Court sentenced the government to save more and faster greenhouse gases than originally planned. The court found that the state had "acted illegally" and "done too little to prevent dangerous climate change".
Justification: There is a broad consensus in the international community that greenhouse gas emissions in the industrialised countries must be reduced urgently.
The ruling: By the end of 2020, the Netherlands must now reduce greenhouse gas emissions by 25% compared to 1990 levels. The planned reduction was only 23%. The environmental organisation Urgenda had already gone to court in 2013 with almost 900 private plaintiffs behind it and has now won in the last instance!

Example Switzerland: A group of activists called "KlimaSeniorinnen" filed a complaint with the Swiss Federal Supreme Court because the heating of the climate was endangering their health and the state was not doing enough about it.

Example Massachusetts: Attorney General Maura Healey filed a complaint against the energy company Exxon because the company violates the rights of consumers and investors. The company's management had concealed in its studies that climate change was having a negative impact on its business.

Take the European Court of Justice, for example: 36 citizens are taking legal action against the EU in the second instance because its climate directives are not strict enough.

In the meantime, Greenpeace, Deutsche Umwelthilfe, Germanwatch, BUND, Luisa Neubauer, Linus and other activists of the Fridays for Future movement, the lawyer Yi Yi and nine Bangladeshi citizens affected by climate change have joined forces and filed a complaint with the Constitutional Court.

Such "strategic lawsuits" promote "court activism" in the hope of influencing governments. Not least against this background, entrepreneurs, developers, industrial companies and the government are obliged to look for further resources to save CO2. This includes a more intensive use of the natural resource daylight, especially in administration buildings, school buildings, sports halls, conference and museum buildings.

State building authorities must fear being sued because of this activism if not all available resources are used to save energy - including the free use of the resource daylight.

Daylight replaces electric lighting without to waste energy!

Based on the declaration of a pandemic by the WHO, parents in particular can sue for the risk of short-sightedness in school-age children. The cause of myopia is an insufficient supply of intense daylight.
Often in competitive tenders worthwhile measures to save CO2 and improved daylight supply are demanded, but are later dropped for cost reasons in the construction process. Exactly these savings can cost the state dearly when the wave of lawsuits rolls in. Energy saving and healthy building is not a "nice to have". It is a task for society as a whole, which we all have to face up to.

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