

D/A

DAYLIGHT & ARCHITECTURE MAGAZINE BY
VELUX GROUP AUTUMN 2015 ISSUE 24 10 EURO
DAYLIGHT AS A DRIVER OF CHANGE





VELUX EDITORIAL

DAYLIGHT AS A DRIVER OF CHANGE

Daylight/Architecture 24 celebrates the potential of natural light to improve lives. Its publication coincides with the 6th VELUX Daylight Symposium in London, which is part of the official program of the UNESCO International Year of Light 2015. The Symposium supports the specific focus of the UN's initiative on improved public and political understanding of the central role of light in the modern world.

Improving lives goes hand in hand with improving health. Hippocrates of Kos (c. 460–370 BC), considered to be the 'Father of Western Medicine', is renowned for his planning advice for health, in which he assigned sunlight, baths and fresh air a central role in the way cities and buildings were planned. His considerations are currently being re-introduced in planning, building and healthcare. The cover image and the photography by Ole Christiansen in this issue reflect this re-orientation and illustrate how much our current thinking and architecture still owe to the builders, scientists and philosophers of antiquity.

There are good reasons for the current rediscovery of Hippocrates' wisdom. Research shows again and again that we cannot take healthy living conditions for granted. An estimated 80 million people in Europe still live in damp dwellings, and some 2 million people suffer from asthma for precisely this reason. Lack of daylight in our indoor lifestyle is just as widespread – leading not only to seasonal affective disorder and sleep problems but also potentially to an almost endemic increase in myopia (short-sightedness) in industrialised nations.

Building on this knowledge, Daylight/Architecture #24 raises important questions on how exactly to change the everyday practice of building design. What framework conditions need to be modified if we want to see more and better daylighting in buildings? What role does the education of architects

play in this respect, and what can scientists, the industry and political decision-makers contribute? We have put these questions to some of the world's leading daylighting experts, and their contributions form the centrepiece of the magazine. Further reflections on them can be found on the www.thedaylightsite.com blog.

Furthermore, two of the most pre-eminent figures in contemporary art and architecture, Olafur Eliasson and Craig Dykers, share their reflections on light, darkness and the stimulation of our senses in this issue. "Sunlight is a prerequisite for physical health, affecting our bodies through numerous non-visual pathways. The body and mind interacting with light is one of the sensory conditions that every architect has to contend with if the buildings we create are to foster wellbeing", writes Craig Dykers in his essay. Dykers is co-founder of the architects' office, Snøhetta, well known for projects like the Alexandria Library in Egypt, the National Opera in Oslo and the National September 11 Memorial Museum in New York. He also served on the jury for the International VELUX Award 2004 and 2014.

Olafur Eliasson, the artist and creator of such memorable installations as The Weather Project at London's Tate Modern (2003) and the New York City Waterfalls (2008), speaks to us about one of his most recent undertakings. The Natural Light project, which was initiated by the VELUX Group together with Little Sun (a social enterprise co-founded by Eliasson), aims to enable thousands of disadvantaged people in off-grid regions in Africa to harness the power of the sun in order to light their homes. It thereby demonstrates in a nutshell how light can not just improve individual lives but be a driver of change for entire communities.

Enjoy the read!
The VELUX Group



D/A

VELUX Editorial	1
Contents	2
Towards a healthier indoor life	4
Light as a global resource	10
Light or dark	18
The rhythm of eternity	24
Quo vadis, daylighting? The future of a vital resource	40
Hooked on light – The 'Natural Light' project	74



OLAFUR ELIASSON: THE WEATHER PROJECT, 2003



PHOTO BY OLE CHRISTIANSEN



PHOTO BY THEKLA EBLING

4
**TOWARDS A HEALTHIER
INDOOR LIFE**

Simple though it may seem, building healthier buildings is a multi-faceted challenge. Owners and occupants need to be informed about how buildings affect our health, architects need to be trained and provided with appropriate design tools, and legally binding standards for daylight and fresh air need to be promoted. But above all, what is needed are pioneers who are willing to invest in healthier buildings.

10
**LIGHT AS A GLOBAL
RESOURCE**

Every one of us perceives light in a different manner – yet we all need it to survive. This insight has been central to the work of Olafur Eliasson throughout his career. In an interview with Daylight/Architecture, Eliasson recalls how he first became aware of the importance of daylight, how light enhances our perception of space, and why he now focuses much of his efforts on introducing sustainably generated light into the off-grid regions of the world.

18
LIGHT OR DARK

Light provides an intellectual and physical form to our world. It enables us to experience architecture, conditions our behaviour in space and is a fundamental requirement to our health. Starting with the stoa in ancient Athens, Craig Dykers explains what role light and darkness play in architecture, and particularly in the works of his own office, Snøhetta.

24
**THE RHYTHM OF
ETERNITY**

The temples of ancient Greece manifest an architecture of contrasts: between mass and space, volumes and voids as well as between eternal proportions and the ever-changing path of the sun. On the longest day of the year – 21 June 2015 – the photographer Ole Christiansen has captured the interplay of light and shadows on the walls, friezes and columns of the Acropolis in Athens.

40
**QUO VADIS, DAYLIGHTING?
THE FUTURE OF A VITAL
RESOURCE**

For decades, daylighting design played rather a side role in architecture, but this has dramatically changed in the last 15 years. Today, daylight is once again considered a clue to healthy and energy-efficient buildings. In their contributions, 12 leading experts from the field of daylighting discuss the consequences of this paradigm change and explain their ideas on how to make good daylighting a matter of course in the design of any building.

74
**HOOKED ON LIGHT
THE 'NATURAL LIGHT'
PROJECT**

Just how indispensable light is to human life becomes obvious in the homes of 1.1 billion people living in off-grid parts of the world. To provide them with a livelihood as well as an opportunity for study, work and social encounter, the VELUX Group has initiated the 'Natural Light' project together with the social business, Little Sun. Its goal is to sell thousands of solar-powered lamps in several African countries and thus to render their owners independent of fossil fuels.

“The sun is the master of life ... The sun must penetrate every dwelling several hours a day even during the season when sunlight is most scarce. Society will no longer tolerate a situation where entire families are cut off from the sun and thus doomed to declining health.”

Le Corbusier in: The Athens Charter, 1942

TOWARDS A HEALTHIER INDOOR LIFE

By Jakob Schoof

THE TONE OF VOICE OF Le Corbusier's demand from the Athens Charter testifies to the trauma that tuberculosis and other infectious epidemics had caused in the cities of the late 19th century. For the architects of Classic Modernism, it was clear that buildings could – and had to – make a contribution to human health. Indeed, we should still be aware of this today in view of what the World Health Organisation (WHO) has to say in its 'Determinants of Health': "Whether people are healthy or not, is determined by their circumstances and environment. To a large extent, factors such as where we live, the state of our environment, genetics, our income and education level, and our relationships with friends and family all have considerable impacts on health, whereas the more commonly considered factors, such as access and use of health care services, often have less of an impact."¹

For decades, however, such truths were all but forgotten. During the 'fluorescent dark ages', as Nick Baker from the University of Cambridge calls them,² humanity succumbed to two dangerous illusions: that light is only for seeing and that the illnesses of the world can be kept in check with medicines alone.

As early as 1941, an article in the magazine 'Architectural Forum' featured the world's first windowless factory, claiming that its benefits included "weather that's always fair" and "a higher level of production, output and quality". The text culminates in the sentence "Two years of experience have proved that buildings need not be designed with windows – that they're better without them."³

This attitude continued to dominate the architectural discourse in the first post-war decades. In 1965, a congress of occupational medicine stated: "Humans in windowless work rooms do not have to fear health impairing impacts of the environment as long as that environment is optimal from the point of view of work hygiene." And as the German daylighting expert Ahmet E. Cakir states, "according to German law until 2004, daylight was not lighting, and what one should understand as healthy lighting

has been defined in lighting standards for artificial lighting."⁴

In other countries, the situation was similar. But now, with public health costs escalating, the question arises with a new level of urgency as to where the solution of the world's health problems is to be found.

LIVING HEALTHIER INSTEAD OF SWALLOWING PILLS: FOR A CHANGE OF PARADIGM IN HEALTHCARE

A lot speaks in favour of making a start where people in industrialised countries now spend 90 per cent of their time – in buildings. It is no coincidence that tuberculosis is once again rampant, primarily where people live closely packed together in unhygienic conditions in damp and dark houses. And the air pollution inside buildings is now responsible for more deaths worldwide than living outdoors.⁵

The challenges, however, are by no means restricted to the developing nations, where many people still cook on wood or coal stoves and illuminate their homes with kerosene lamps. According to projections of the Fraunhofer Institute for Building Physics, two million people in the European Union suffer from asthma because they live in damp rooms.⁶ One of the main reasons for this is insufficient ventilation, which prevails in around half of all dwellings in Europe⁷ and in as many as 87% of all classrooms.⁸

In the meantime, it is becoming increasingly clear that the benefits of fresh air and daylight are economically relevant both for businesses and societies at large. For example, too little light during the day and too much light at night are also among the main reasons for sleeping problems, which now affect 15 to 30% of the working population. According to estimates, the economic loss due to insomnia is around 100 billion dollars a year in the USA alone.⁹

More recent studies even corroborate a suspicion that has been circulating in the population for decades but has been denied by most scientists, namely

that our increasingly indoor lifestyle leads to myopia. Poor eyesight is now taking on epidemic proportions, especially in Asian countries where living conditions have changed drastically in recent decades. Sixty years ago, 10 to 20 per cent of all Chinese people suffered from myopia; today, 90 per cent of all teenagers and young adults there already have this problem.¹⁰ Here as well, estimates have been made regarding the resulting costs: according to a publication of the WHO, the global loss of productivity due to myopia was almost 270 billion dollars in 2007.¹¹

For decades, scientists blamed our genes for our poor eyesight but this does not explain the rapid rise in myopia in the last 50 years. Even reading or working on the computer for hours on end does not, in itself, increase the risk of short-sightedness. Scientists have now made out one simple factor: city dwellers do not spend enough time outdoors and therefore do not sufficiently expose their eyes to daylight. Even animal experiments confirm this relationship. If young chickens are exposed to bright light that is approximately on the level of daylight, the probability that they will become short-sighted decreases by 60 per cent.

BUILDING FOR HEALTH PAYS OFF – IF THE RIGHT STANDARDS ARE APPLIED

The health benefits of daylight ought to make the eyes of all employers light up. A common rule-of-thumb says that, out of the total cost of ownership per workplace for an office building, around 90 per cent is accounted for by salaries and ancillary wage costs, 9 per cent by rent and only 1 per cent by energy costs.¹² Vivian Loftness and her colleagues from the Carnegie Mellon University in Pittsburgh (USA) have calculated the proportions even more precisely.¹³ According to their investigations, a five per cent increase in labour productivity due to more fresh air and better light – something that can easily be achieved – saves an employer as much money as a 70 per cent rent reduction or five times the energy costs.

This comparison shows not only that investing in health and well-being is worthwhile but also that many sensible measures only pay off if the social and health costs, rather than just the energy costs, are taken into account. While the economic return on investment of operable windows and shading systems is often less than 20 per cent, the aggregated economic, ecological and social rates of return amount to over 100 per cent in both subtropical and temperate climates. In other words, the investment will pay back in less than a year if all dimensions of sustainability are considered.¹⁴

NATURALLY: MORE DAYLIGHT AND FRESH AIR IN BUILDINGS

The figures by Loftness et al. from the Carnegie Mellon University alone should convince any building owner to invest in healthier buildings. But, in reality, this does not happen as frequently as it should.

If we want to change this situation, simplistic attempts at solutions will not lead us very far. The benefits of better daylight and indoor air quality may be convincing and straightforward but to harness them, we need to devise strategies that operate in many different fields, from information campaigns to legislation and from design tools to real-life experiments. The following paragraphs present a cursory – and, by necessity, incomplete – overview of what is needed.

I Talking about health

building owners today are often surprisingly well aware of how to save energy in the home. But they frequently know much less about measures that can positively enhance health and well-being. Change can only be brought about if the public discourse on building is re-directed towards what really makes life worth living. Legislation should also make a contribution to this. In a recently published report, the Buildings Performance Institute of Europe (BPIE) made a statement to this effect: “Indoor air quality, thermal comfort and daylight indicators should be integrated in the Energy Performance Certificate as relevant information regarding the actual living conditions in the building.”¹⁵

And that’s not all. It seems as if people who should actually know better are often the ones who are the most clueless about this issue. A survey of the American Institute of Architects in 2014 showed that only 32% of all general practitioners and 40% of all psychologists thought that buildings have an impact on the health of their occupants. With paediatricians, the rate of positive responses was just over 50% but this is still shamefully low.¹⁶

II Quantifying health impacts

this may sound like a contradiction to many architects. But in order to convince more clients of the need for healthy buildings, it will be essential to express their benefits in dollars and cents. The research results obtained up to now are impressive but can only be a beginning, especially as the findings so far are often rough estimates and the exact values per building vary a

great deal in reality. In future, we need a much wider database for different types of building and climate zones, as well as convincing success stories.

III Prioritising health

sustainable building concerns much more than merely energy efficiency. But many certification systems for sustainable buildings confront clients with lists of sixty or more criteria. And only a fraction of them are aimed at promoting the occupants’ health and well-being. We therefore need building standards that set the right priorities. Good examples of this are the guidelines of the international Active House Alliance¹⁷ and the standards of the German association AktivPlus e. V.¹⁸ Both place people at the centre of things and guarantee a high degree of well-being with their stringent requirements regarding the level of daylight and the supply of fresh air.

IV Designing for daylight and health

daylight changes continuously, throughout the day and the seasons – and with it, so does the indoor climate. This variability is what makes it so fascinating but, for a long time, meant that daylight was very difficult to plan for. According to the American architect and daylight expert, Lisa Hescong, many lighting designers “generally don’t trust daylight and don’t often know how to think about variable environments.”¹⁹

But the situation is changing. Today, simple building simulation tools²⁰ enable architects to find out, in an accessible and intuitive way, how certain design strategies affect daylight and indoor climate in buildings. In building design, it can only be a question of time before their use is widespread. This will be assured by the growing affinity of young ‘digital natives’ for such tools and by the increasing ease of data exchange between programs for drawing, designing and simulation.

V Ensuring a healthy indoor climate

“In theory, theory and practice are the same. In practice, they are not.” This simple adage is attributed to Albert Einstein, perhaps the greatest theoretician of the 20th century.

For the building industry, however, it has taken a long while to realise that the quality assurance process does not come to an end with the completion of a building. It also applies to the aspects of indoor climate that determine

health and well-being in buildings. As the social scientists Bernd Wegener and Moritz Fedkenheuer point out, well-being cannot be prescribed by architects and planners but is highly user-dependent.²¹ Similarly, health in buildings is determined by multiple variables, including the disposition of each individual person. For this reason, it is important that, after their completion, buildings are not only monitored in a technical sense, but in terms of their effect on – and interaction with – the residents. This can be achieved with relatively simple means, such as Internet-based questionnaires.

VI Making healthy living simple

buildings have become ever more complex, largely – but not exclusively – for reasons of increasing energy efficiency. More and more building users, but also experts from the building industry, are therefore calling for more simplicity. From a psychological point of view, they are right: finding one’s way around in buildings intuitively is a precondition for well-being.

However, simplicity does not mean that all functions should only be controlled manually – especially not in buildings that are supposed to fulfil the maximum requirements in terms of energy efficiency and the indoor climate. As the results of the VELUX Healthy Homes Barometer 2015 have shown, people often do not sufficiently ventilate their homes if left to their own devices.²² Automated windows may be a great help in this respect. The same applies to shading systems if indoor temperatures are to remain comfortable in summer.

A number of factors are critical for the success of automated control systems – such as intuitive usability, reliable technical support and easy-to-understand feedback on the effects of one’s own behaviour. The most important factor, however, is the possibility of manual intervention at any time. Automation has nothing to do with overruling or disempowering the user – on the contrary: he or she should remain in control of the house at any time.

VII Making healthy building obligatory

while voluntary standards and the ‘good will’ of individual clients are important steps towards healthier buildings, the role of legislators is absolutely vital in this regard. According to a recent report by the Buildings Performance Institute Europe (BPIE),²³ only four of the eight EU

member states and regions examined had mandatory minimum standards for daylighting in dwellings. And these were often fairly low, with Sweden stipulating a window/floor area ratio of 10%, which is roughly equivalent to a daylight factor of 1.0; Germany recommends only 0.9 on average for rooms in dwellings.

The situation is even more difficult when it comes to the refurbishment of existing buildings. According to the BPIE report, “no requirements have been identified across the surveyed building codes stipulating any minimal daylight preservation when renovating a building, except in the UK where the ‘Right to Light’²⁴ regulation is in place.”

In terms of indoor air quality, the authors of the study have also identified significant shortcomings in national legislation: “Strict and legally-binding requirements, such as minimum ventilation rates, airtightness or limitation of pollutants, can hardly be found in the analysed building codes.”

VIII Building for health!

There is yet another reason why it is hardly sufficient to wait for building owners and users to ask for higher quality. In everyday life, people are satisfied with a level of daylight that is clearly too low from a health point of view. This was shown by the results of the Healthy Homes Barometer²⁵ among other things. In a field study carried out by the Technical University of Berlin, a majority of people questioned felt a daylight factor of 2.0 inside dwellings to be sufficient.²⁶ With a median external illuminance of 15,000 lux, this results in an indoor illuminance level of 300 lux, which may be sufficient for visual tasks but means “near darkness for the circadian system”, as the chronobiologist Anna Wirtz-Justice puts it.²⁷ Scientists now agree that illuminances of well over 1,000 lux are needed to adequately maintain the circadian rhythm.

The good news, in contrast, is that, for users, a room can hardly be too bright. The participants in the experiment did not judge even daylight factors of 5 to 10 to be too high. The positive effects of such high levels of daylight have been impressively underlined by the VELUX Model Home 2020 project.²⁸ Moritz Fedkenheuer sums up the results as follows: “The experiment showed that well designed, modern homes are able to alleviate, or even resolve, health problems such as asthma or allergies, that they im-

prove the self-reported mood and productivity and also stimulate a healthier lifestyle. However, the participants in the experiment were not aware of the immense benefit that comes with daylight and fresh air until they experienced it in the context of this experiment. It seemed as if the abundance of daylight and fresh air had uncovered a latent need in their bodies.”²⁹

DO IT RIGHT THIS TIME!

The benefits of daylight and fresh air in buildings are intuitively comprehensible and have been verified scientifically. But decisions in architecture and the building industry are often not made on the basis of knowledge and intuition but characterised by scepticism and risk aversion. Anyone who wants to change this situation must engage with many factors – science, education and legislation, to mention just some – simultaneously. Above all, however, pioneers with the courage to build healthier buildings are called for. We need even more – and affordable – exemplary homes, offices and schools across Europe that are not only designed for energy efficiency but, first and foremost, for the health of their residents. Given the escalating demand for new construction in many European metropolises, there is an urgent need that we ‘do it right’ this time after having neglected daylight and fresh air for decades in the second half of the twentieth century.

Notes

1. <http://www.who.int/hia/evidence/doh/en/>
2. Baker N: Daylight inside and the world outside, Daylight&Architecture 11, p. 50ff.
3. Take a second look at the world’s first windowless plant. Architectural Forum, November 1941, p. 57
4. Quoted in: Cakir AE, Daylight for Health and Efficiency – a new career for an old friend, www.lichtundgesundheit.de/cyberlux/wp-content/uploads/2009/12/Istanbul.pdf
5. World Health Organisation: 7 million premature deaths annually linked to air pollution. Press release, 25 March 2014, www.who.int/mediacentre/news/releases/2014/air-pollution/en/
6. Presentation by Prof Dr Gunnar Grün at the 2nd AktivPlus-Symposium. Stuttgart, 21 May 2015
7. Dimitroulopoulou, C., 2012. Ventilation in European Dwellings: A Review. Building and Environment 47(1): 109–125
8. Haverinen-Shaughnessy U, Moschandreas DJ, Shaughnessy RJ: Association between standard classroom ventilation rates and students’ academic achievement. *Indoor Air* 2011, 21:121–131
9. Metlaine A, Leger D, Choudat D: Socioeconomic Impact of Insomnia in Working Populations. *Industrial Health* 2005, 43: 11–19
10. Dolgin E: The myopia boom. *Nature*, 18. March 2015. www.nature.com/news/the-myopia-boom-1.17120 Hobday R: Myopia and daylight in school: a neglected aspect of public health? *Perspectives in Public Health* 175791391557-6679, 23 March 2015
11. Smith TST et al: Potential lost productivity resulting from the global burden of uncorrected refractive error. *Bulletin of the World Health Organization* 2009; 87(6): 431–7
12. World Green Building Council (pub.): Health, Wellbeing & Productivity in Offices. Full report, p. 6. http://www.worldgbc.org/files/6314/-1152/0821/WorldGBC__Health_Wellbeing__productivity_Full_Report.pdf
13. Loftness V et al.: Building Investment Decision Support (BIDS). www.aia.org/aiaucmp/groups/ek_public/documents/pdf/aiap0800-50.pdf
14. See also Loftness V et al.: The Triple Bottom Line Benefits of Climate-Responsive Dynamic Facades. Presentation at the PLEA Conference 2014
15. Buildings Performance Institute Europe: Indoor Air Quality, Thermal Comfort and Daylight. March 2015. <http://bpie.eu/indoor.html#VXF0-WGYkoi0>
16. McGraw-Hill Construction/American Institute of Architects: The Drive Toward Healthier Buildings, 2014, p. 4. www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab104164.pdf
17. www.activehouse.info
18. www.aktivplusev.de
19. Quoted in Rose SW: The 7 Market Obstacles to Daylighting. LD+A, February 2014, p. 50 ff.
20. Some of the many available tools are the VELUX Daylight Visualizer (viz.velux.com) or the VELUX Energy and Indoor Climate Visualizer (eic.velux.com). A good overview of available tools and their potential can be found in Statens Byggeforskningsinstitut (ed.): Daylight calculations in practice, www.sbi.dk/indeklimalys/daylight-calculations-in-practice
21. Fedkenheuer M, Wegener B: The Housing Well-Being Inventory: understanding how people interact with their homes. Daylight/Architecture 23, p. 33 ff.
22. www.velux.com/healthyhomes
23. Buildings Performance Institute Europe: Indoor Air Quality, Thermal Comfort and Daylight. March 2015. <http://bpie.eu/indoor.html#VXF0-WGYkoi0>
24. Right to light is a regulation in English law that gives a long-standing owner of a building with windows a right to maintain the level of illumination. In effect, the regulation entitles the owner of a building that has received natural daylight for 20 years or more to forbid any construction or other obstruction that would deprive him or her of that illumination.
25. see note 22
26. Völker S et al: Tageslichtnutzung in Wohn- und Arbeitsräumen zur Verbesserung der visuellen Behaglichkeit und der Aufenthaltsqualität. www.irbnet.de/daten/rswb/14109007761.pdf
27. Wirtz-Justice A, Fournier C: Light, Health and Wellbeing: Implications from chronobiology for architectural design. *World Health Design*, January 2010. For a brief overview of the factors that affect our circadian rhythm, see also: Schoof J, Sleep, Work Live. Daylight/Architecture 22, p. 35 ff.
28. <http://presse.velux.de/model-home/> www.velux.com/sustainable_living/sustainable_buildings?keywords=model%20home%-202020&resNum=7
29. Fedkenheuer M: Daylight and ventilation make better places for living. Daylight/Architecture 23, p. 47 ff.



PHOTO BY ARI MAGG

LIGHT AS A GLOBAL RESOURCE

Interview by Jakob Schoof

“If you actually understand the daylight potential – the heliotropic potential as it were – of a space, I think that you can build without a lot of artificial light.”

Olafur Eliasson



OLAFUR ELIASSON, ICE WATCH, 2014. PHOTO BY ANDERS SJÖBERG

THROUGHOUT HIS CAREER as an artist, Olafur Eliasson has been exploring how light affects human perception, social life and well-being. Now the Danish-Icelandic artist and his social business, Little Sun, have teamed up with the VELUX Group to launch Natural Light. The design competition aims to bring solar-generated light into off-grid regions of the world, thus replacing inefficient and polluting kerosene lamps (see the article *Hooked on Light* in this issue). Furthermore, Olafur Eliasson is a keynote speaker at this year's VELUX Daylight Symposium in London. In an interview with *Daylight/Architecture*, he explained how light changed his life as a little boy, how he deals with the uniqueness of daylight as an artist today, and what he hopes to achieve with Little Sun and the Natural Light project in the future.

Mr. Eliasson, you will be speaking at this year's VELUX Daylight Symposium in London, for which the organisers have chosen the theme Daylight as a Driver of Change. When in your life did you first experience how light can change human lives?

It must have been when I was around five years old, spending the summer in Iceland at my grandparents' home. It was the time of the oil crisis in Europe, and since Iceland had not yet developed the geothermal sources of energy it has today, the government had rationed the use of energy. This meant that after dinner time, the power would be cut off, as if there had been a blackout. However, as it is still light outside in Iceland at that time of the year, we would all either go outside, if the weather allowed, or move our activities to the windows where there was this very beautiful blue summer light. Sitting by the window with this very atmospheric light made me aware, not just of the difference between incandescent light and daylight, but that you could actually use this little bit of blue light. Previously, when the electricity had been on, it seemed that the light outside was just dark or irrelevant, but once you did not have electricity, the daylight started to mean a lot, it became incredibly important.

As an artist, what is the main difference in your experience between working with daylight and working with artificial light?

Clearly, we only see things when light falls upon them or comes from them. Hence, a main focus of my work has always been on how light changes our perception of reality and enhances the quality of our experience. When it comes to daylight, I've been looking a lot at differences in its distribution around the globe. In Iceland, for example, the sun travels very low on the horizon. Thus, for more than two thirds of the day, the shadow is longer than the object that casts the shadow. The landscape as well as objects and faces are mostly side-lit with a very strong contrast between shaded and illuminated parts. This is a sort of drama in itself, which differs a lot from the situation in southern countries where the sun climbs very high and leaves almost no shadows.

You can also see these differences reflected in the history of painting. Paintings from Italy, for instance, often depict very little shadows. When Canaletto painted the houses on the Canal Grande in Venice, he painted the shadows between them dark blue – but he did not necessarily sculpt the Venetian cityscape by virtue of shadows. In Dutch or Flemish paintings, by contrast, you have the sun coming from in the side, which produces a different illumination and three-dimensionality.

So there is a difference between how daylight adds perspective or adds dimensions to space. I am actually not so interested in whether daylight is better than electric light, but much more in the fact that light is actually unique everywhere.

How do you reflect this uniqueness in your own work?

Starting from these observations, I became interested in recreating natural phenomena with artificial light, evoking similar experiences or questions, including critical ones. I focused a lot on the emotional effects

“We can ask; what type of identification with a space makes you feel included and welcome and hosted? What architectural resources does it take for the people in the space to feel that they are worth something?”

Olafur Eliasson

of light. What does a warm tone of light do to us? Does it create other social patterns or strategies than cold light? Does cold light facilitate less hospitality? Are these definitions of hospitality versus less hospitality culturally or anthropologically different? I looked a lot at the atmospheric and social aspects of light, but not as a psychologist or a social scientist would do, but from the point of view of an artist.

Speaking of emotions – what qualities does an architectural space require so that you can feel an emotional attachment to it in?

Many people try to set up rules for what is good and bad architecture with regard to emotional responses. However, I think it is necessary to go a few steps deeper and question what an emotional response actually is and how it is caused. Does the response take place at the expense of the spatial atmosphere that the architect sought to create, or does it happen on behalf of it? Furthermore, we can ask what type of identification with a space makes you feel included and welcome and hosted. What architectural resources does it take for the people in the space to feel that they are worth something?

The German philosopher Gernot Böhme has made great achievements in defining a terminology of atmospheric conditions. Quite successfully, he objectified a number of these conditions that could be determined even without taking into account the people, creating them merely with the right kind of space, as it were.

However, I would argue that it always takes a subject, a person, to constitute an atmosphere. Hence atmospheric conditions can be ascribed to the viewer himself, meaning that the architect or artist can hand over their co-production, or even production, to the user.

This mindset is quite important because, as an architect, you sometimes take for granted the fact that you are the author of atmospheric conditions, without taking the user into account. In order to successfully

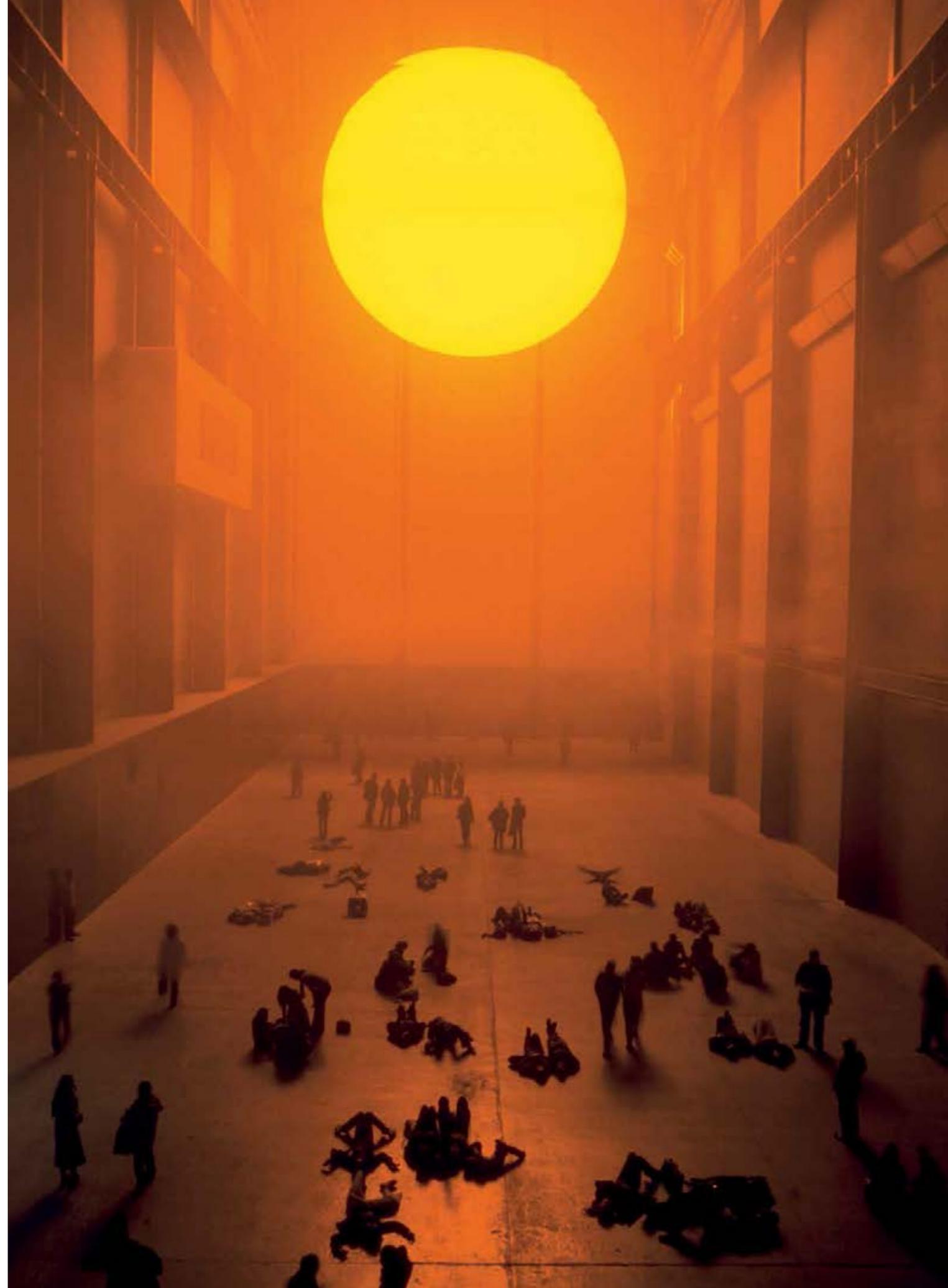
create a great space, however, one has to know how to engage the user in the construction of the space. To me, this is an exercise of trust. The challenge is that architects are rarely educated to verbalise this field of knowledge, nor are they educated to trust people in the spaces they create. As a result, a lot of spaces today claim to be inclusive but are, in fact, exclusive because they do not trust the user to be able to co-produce the atmosphere. In these architectural spaces, identity is not in what you do, but in how you look.

Having made this point, one of the greatest atmospheric drivers is, of course, light. It is both the light that enters the space, as daylight, and the light that is already inside the space, in the right balance. And if you actually understand the daylight potential – the heliotropic potential, as it were – of a space, I think that you can build without a lot of artificial light.

Much of your work is informed by scientific findings. What can the worlds of art and science learn from each other?

Alongside being inspired by scientific findings, art can also learn a lot from the methodology of science: the critical approach to things, the work in a laboratory, the knowledge of how to do empirical tests, and so forth. What art can contribute to science, I think, is its confidence in process-oriented, non-quantifiable success criteria. Science is often very goal-oriented but risks missing out on the unforeseen and unpredictable successes. Furthermore, there is the role of creativity. It would be wrong to say that scientists are not creative, but creativity is something that art nurtures very well for obvious reasons. And part of the notion of creativity is also the relationship between art and the world. To be creative is not just to paint a great painting with great colours, but also to consider the consequences of adding a colour to the work, to ask: what does this work of art do to the world? In a similar way, I think that science can benefit from being creative with regard to understanding its own relationship to the wider world.

OLAFUR ELIASSON. THE WEATHER PROJECT, 2003. PHOTO BY ANDREW DUNKLEY & MARCUS LEITH



“Maybe we should not always try to quantify everything but just do something for the potential of feeling good and happy.”

Olafur Eliasson

What scientific advances do you consider particularly relevant in the field of light?

There have been revolutionary advances in how light is generated and transmitted in recent years, particularly in terms of energy efficiency. What interests me in this respect is that we have a very uneven energy distribution in the world today. There are places, such as Iceland, that literally ‘sit’ on their own – in this case, geothermal – power plant. Then there is the rest of Europe, which is gradually becoming more comfortable with idea of becoming independent of fossil fuels. However, this does not make up for the fact that a very large part of the world does not have access to any form of adequate energy supply. For example, one in seven people in the world are using kerosene as their primary source of light. As kerosene is very expensive, households in rural Africa spend between 15 and 25 % of their monthly income on lighting their homes. Furthermore, this light is not just expensive but also bad for people’s health, as burning kerosene in the home causes respiratory conditions. Hence, there is an urgent need to consider all these new lighting technologies and see how one can apply them with relevant economic models in parts of the world where there is little access to energy or where its price is so high that it keeps these areas from evolving economically.

What was your main inspiration in starting the Little Sun project, which aims to change this situation?

I am utterly convinced that being an artist makes you capable of doing more than just working in the art world. Hence, I wanted to see if I could use this potential, as well as the exposure that I have come to enjoy, within a field that has so far not been associated with art, but without me leaving the art world altogether. As I explained, for a long time I had been interested in the psycho-social impact of access to light on every level of our lives. Furthermore, I had become aware

of the situation in areas without access to energy. I also happened to know a solar engineer, Frederik Ottesen, who was very interested in similar questions. We discussed whether it would be possible to produce something with a high design quality, focusing on non-quantifiable success criteria but at the same time delivering a competitive alternative to kerosene lamps. After all, if we want to get rid of kerosene we need to make access to solar energy cheaper. Moreover, we wanted to do so in an empowering way, not only to provide people with light but also with a business opportunity, or at least a financial benefit. Once they had bought a Little Sun, they would save money for at least three years on kerosene. The savings very quickly amount to the price they would otherwise pay for the fuel, but they have to pay a relatively big sum for the lamp upfront. We therefore wanted to produce and distribute the lamps at the lowest possible cost, and we also sought ways to finance them through micro-loan organisations.

What are the main differences between designing an art project or a luminaire that is produced several thousand times and has to obey the rules of the mass market?

It is true that there are significant differences, and my team is now dealing with a lot of administrative questions that you normally do not have to face as an artist. It is hard to do a work of art, but getting customs clearance to import goods into Ethiopia is a quantum leap in and of itself! What interests me, however, is how the light works once it has made the journey from my sketch through the production machinery and into the hands of the people who are going to be working with it, who need the light. The aim is that this journey becomes sustainable and reflects the overall values of the project. My main focus is on getting the lamps out to where it matters, their impact.

What has been the most important experience you have made with the project in this respect? What

feedback have you received from people who bought and use the lamps?

We often talk about very quantifiable successes such as getting a child to read a book, keeping your kiosk open longer so you can earn more money, improving indoor air in the huts for the health of small children especially, and preventing kerosene lamps from falling over and burning houses. This is the typical way that such projects are discussed, but the truth is what convinces people to buy a lamp is often the irrational, the non-quantifiable aspects. We see people buying the lamp because they want to give it as a present. People are also buying it because the design makes them happy. They buy the lamp because of emotional responses. In a way, this should not surprise me because I would act in the same way. I do not organise my household around the most pragmatic, health-related things but I do things that I think are beautiful and make me happy.

In the industrialised world, we tend to have the idea of Africa being the ‘other place’, but we totally underestimate how much we have in common. Actually, people in Africa want just the same as us: they want to be happy, to have beautiful things in their homes, and to have a safe next day. They want to know whether the school is open. So the Little Sun project is a great deal about suggesting what we have in common, not what is different. And what we have in common is our wish for light and our consciousness about climate change. People in Ethiopia, for instance, are very keen on using renewable energy as it can save them a fair amount of energy, but also because, like everybody else in the world, they are interested in the environment. Why should they not be?

How does this emotional approach relate to your artistic work? What do the two have in common?

Essentially, my approach is the same on both occasions. The focus on the experiential and the emotional components has been central to both my art

Olafur Eliasson (born 1967) grew up in Iceland and Denmark, studied at the Royal Danish Academy of Fine Arts in Copenhagen and subsequently set up his own studio in Berlin, Germany, in 1995. Today, Studio Olafur Eliasson encompasses some ninety craftsmen, technicians, architects, administrators, art historians and other specialists. From 2009 to 2014, Olafur Eliasson held a professorship at the Berlin University of Arts. Among his best-known works are The blind pavilion at the 2003 Biennale of Art in Venice, The weather project (Tate Modern, London 2003), the Serpentine Gallery Pavilion 2007 (London, together with Kjetil Thorsen) and the New York City Waterfalls (2008). In 2012, Eliasson and engineer Frederik Ottesen founded the social business, Little Sun.

work and Little Sun. You don’t go to Africa with a pragmatic answer; you go there with a human eye and with an emotional, socially relevant answer. My art projects often deal with abstraction, something that is non-verbalised, something that is interesting but takes time to engage with and immerse oneself into. This belief in something abstract could actually be very relevant to society. Maybe we should not always try to quantify everything but just do something for the potential of feeling good and happy. This type of compassion-driven thinking is present in my art work, but it also lives in Little Sun. It is not my compassion to a specific person without energy but the kind of compassion that is all around, in-between everyone.

You have now embarked on another design, a new kind of lamp, with the Natural Light competition. How does this fit into your overall strategy for the Little Sun project?

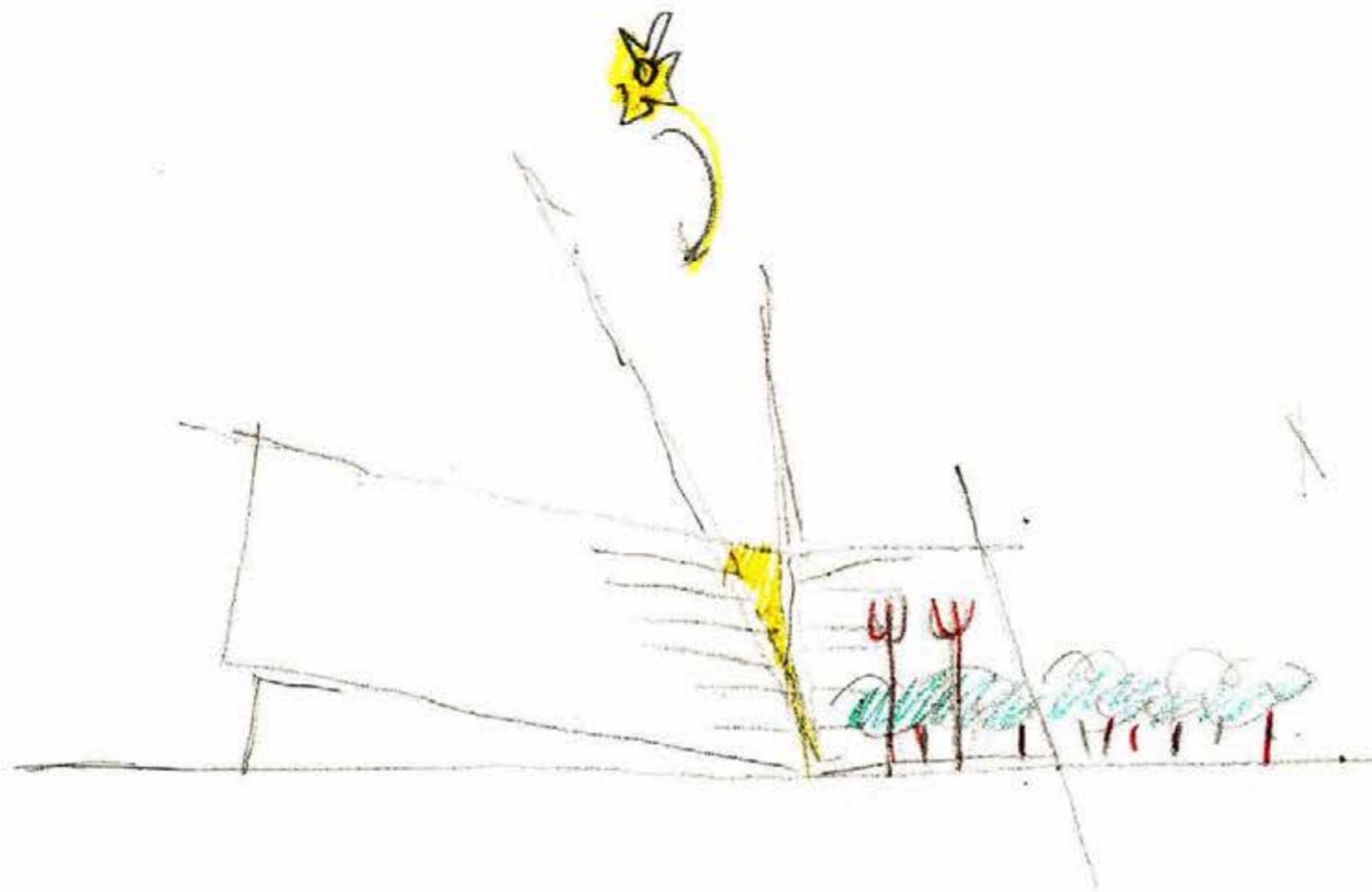
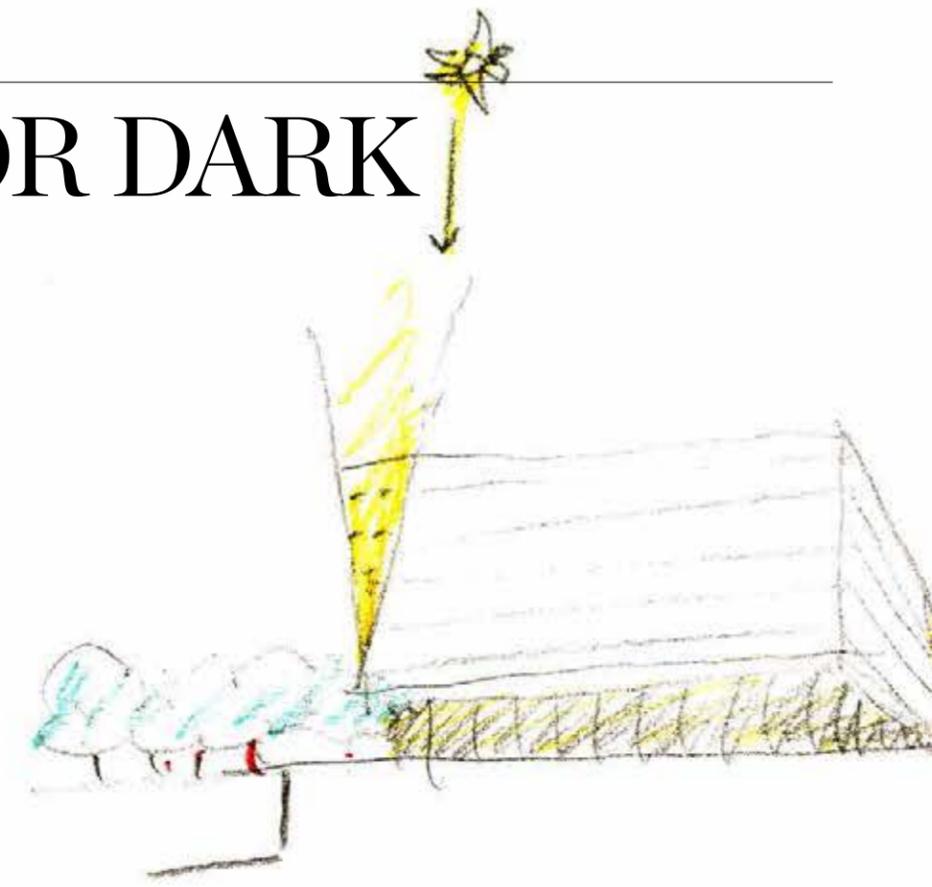
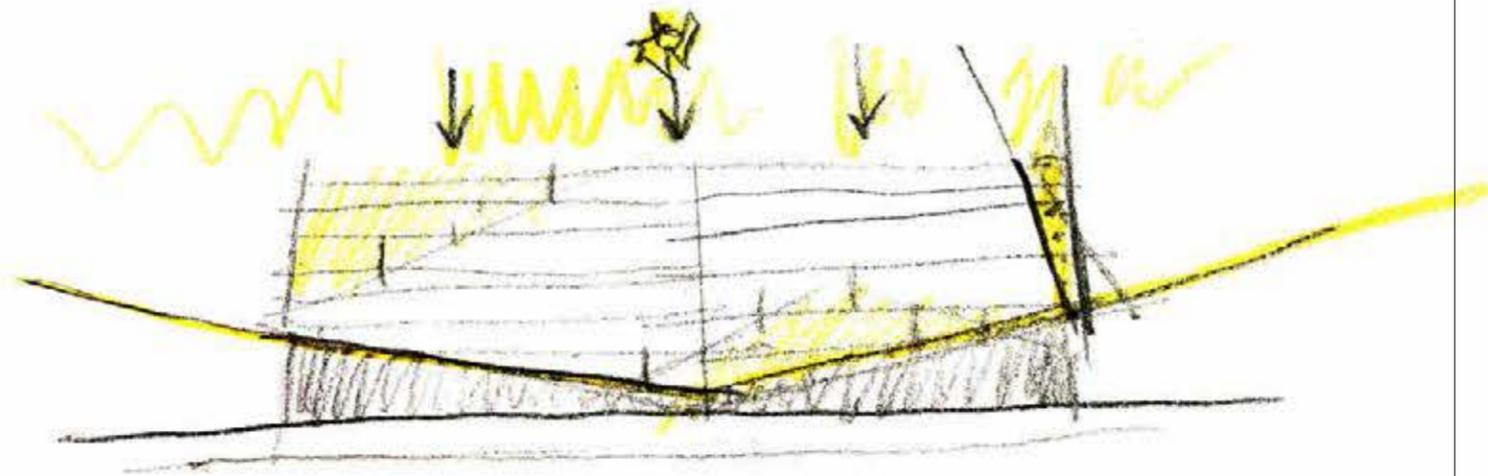
The Natural Light competition was a great collaboration between the VELUX Group and Little Sun. It was an exciting opportunity for us to learn from and work with a company that has the kind of stamina, knowledge base and the resources that the Group VELUX has.

Together, we decided that the competition should reach out to the educational sector, both to encourage young designers to respond to the question of energy supply and to address the fact that, by using the energy of the sun, we can go a long way in this respect. So it was both a design competition and an awareness campaign. In the end, it was really difficult to choose a winner because so many great ideas were submitted by students from all around the world.

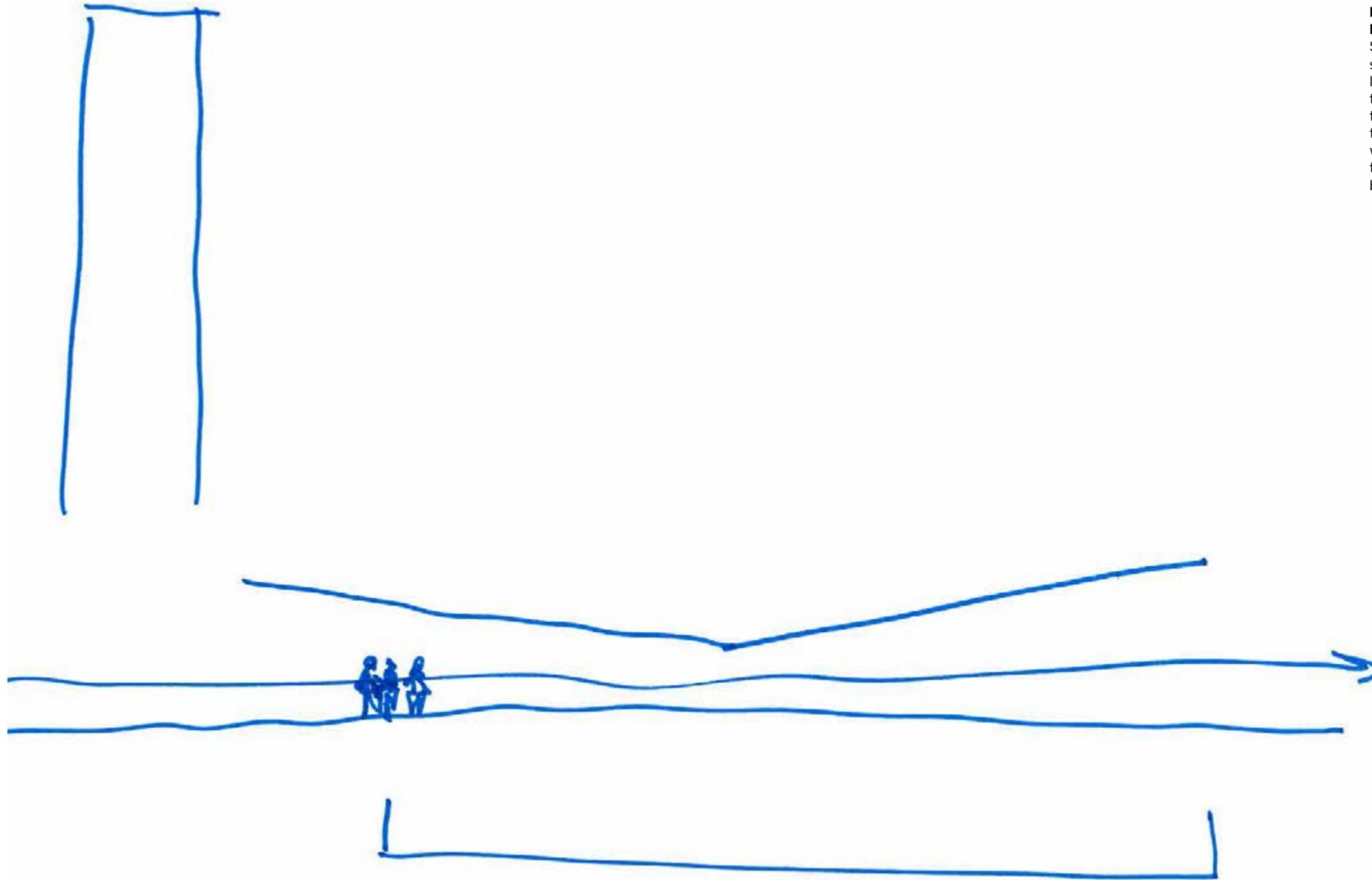
The winning design really delivered on all accounts: it was practical, affordable, beautiful and very convincing in terms of its market potential. We are very curious to test this new lamp in Africa and see if it can bring about new successes that we have not been able to foresee so far.

LIGHT OR DARK

by Craig Dykers



“Light allows us to understand our world by making things visible and by giving us an idea of space and time. Sunlight is a prerequisite for physical health, affecting our bodies through numerous non-visual pathways. The body and mind interacting with light is one of the sensory conditions that every architect has to contend with if the buildings we create are to foster well-being.”



National September 11 Memorial Museum Pavilion, New York City, 2004 – 2014

Snøhetta's entrance pavilion is the only building that sits right at 'Ground Zero' in New York. The irregularly shaped glass and steel volume serves as an entrance building to the largely subterranean museum that commemorates the 9/11 attacks. According to Snøhetta, it "acts as a bridge between two worlds – between the memorial and the museum, the above and below ground, the light and dark, and between collective and individual experiences."

PERHAPS THE STUDY OF LIGHT is the study of time. The sun is an ancestral force. Each thing we see actually existed a moment before. When light is made, it is sent into the future. If it is set free, we will never know where it will end. Humans have been manipulating and experimenting with light for millennia. Harnessing fire allowed us to bring light into places that only knew darkness, exposing us to worlds that our past could not prepare us for.

According to scientists, our sun was born about 4.6 billion years ago and at very nearly the same time our earth was also formed. Soon thereafter, a celestial collision created our moon. Our earth and sun are very close relatives, almost inseparable in age and place. We are bound to our relationship with the sun.

This relationship dominates our planet and our existence, even as we walk in space. By coincidence, the size of the moon and its unique position between the earth and sun created the eclipse, allowing us to experience time in an unexpected way. Light provides an intellectual as well as physical form to our world.

As an architect, I have been unable to ignore these rather obvious conditions. But what does that really mean?

Sunlight is something we cannot be without. In recent years, we have seen the increase of health problems related to some architectural design decisions that ignore this basic relationship. Many of these problems have been related to lack of sufficient fresh air and natural light. It is readily apparent that

light and air share common paths toward health. We cannot be without whatever it is the sun gives us.

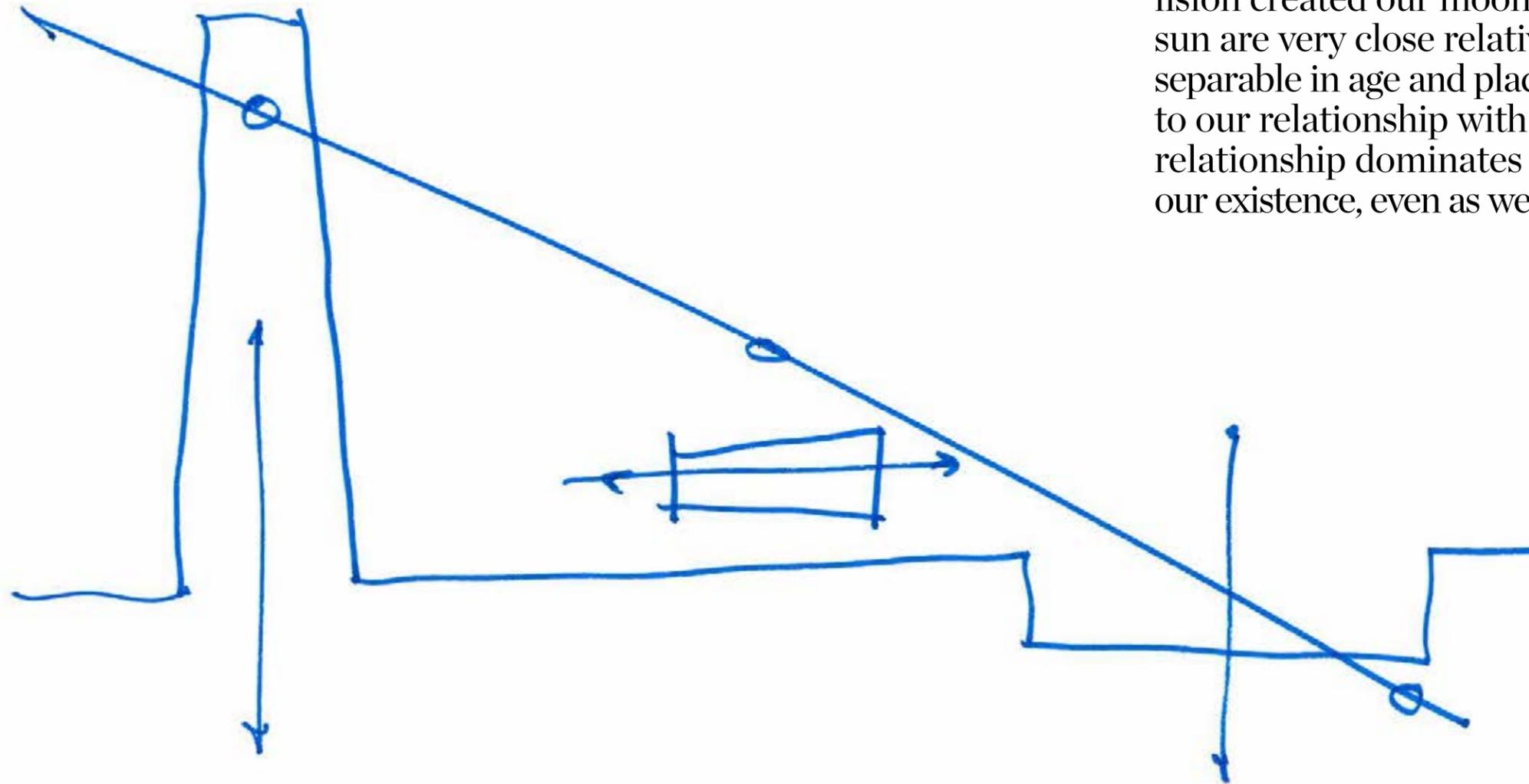
Light is not only an ephemeral condition, it is physical. There is no good replacement for direct contact with the sun. Sitting behind a clear window does not provide the same amount of vitamin D as the same time spent in the sun. But even behind a window, encountering light on one side or the other of our body is registered unconsciously. Our bodies gauge the variations. Changing the body's direction in relation to direct light allows the body to align with the specific light condition. The value of our bodies measuring daylight is so important that it is true for both the blind and sighted.

THE STOA, A PLACE BETWEEN LIGHT AND DARK

One of the earliest structures dedicated to knowledge, the forerunner of our modern libraries, was the stoa. In ancient Greece, the stoa was a temple-like structure – but different in many ways. It is wider than it is deep and its axis of movement is generally perpendicular to the direction in which it is entered. Like a porch, one wall of the stoa is colonnaded and open to the exterior. A portico at a temple is meant primarily to frame a smaller doorway. The temple is dedicated to revering wisdom, the stoa is dedicated to creating wisdom.

Several features of the stoa are relevant to the understanding of physical well-being and the relationship between the body and mind. In a stoa, peo-

Craig Dykers is a founding partner of the design and architecture office Snøhetta. He has led many of Snøhetta's prominent projects including the Alexandria Library in Egypt, the Norwegian National Opera and Ballet in Oslo, the National September 11 Memorial Museum Pavilion in New York City, the new San Francisco Museum of Modern Art and the recently completed Ryerson University Student Learning Centre in Toronto. Craig's and his partner's work at Snøhetta has been awarded, amongst others, the Mies van der Rohe European Union Prize for Architecture, the World Architecture Award, and the Aga Khan Award for Architecture. In 2004 and in 2014, Craig Dykers was a jury member of the International VELUX Award for Students of Architecture.



According to scientists, our sun was born about 4.6 billion years ago and at very nearly the same time our earth was also formed. Soon thereafter, a celestial collision created our moon. Our earth and sun are very close relatives, almost inseparable in age and place. We are bound to our relationship with the sun. This relationship dominates our planet and our existence, even as we walk in space.

ple moved along the long axis, discussing theory or simply reviewing the day's affairs. They would walk from one end of the stoa to the other, turn around and repeat the stroll. Each time a return trip was made the light and the dark sides of the room in relation to the body would switch. There was never a single relation to light in these spaces. These types of spaces became the foundation of the Academia where Aristotle, Socrates and Plato built the philosophical agendas that most of the western world is founded on today. Physical movement combined with a relationship to light promotes well-being both physically and intellectually.

We have used this simple principle in many of our built designs. A survey of almost any of our works will

expose this. Such planning is, however, generally invisible, or at least it does not readily show itself in the way most people think, formally.

Our oldest and our newest project are two libraries where this thinking is embedded. The Library of Alexandria is framed by a vast roof that holds, spreads and nourishes light in changing directions throughout the day. The Ryerson Learning Centre in Toronto captures the shapes of clouds, sunlight interacts with multicoloured floors and draws you in and out of the building by reflection.

LIGHT AS A CATALYST OF HUMAN BEHAVIOUR

The September 11 Memorial Museum Pavilion in New York City bends light. At times, even its north-

ern facade reflects natural light; this is mirrored in the atrium glass, inviting visitors to approach and move alongside the building. In a similar way the new San Francisco Museum of Modern Art does not use windows alone to manage light. Softly undulating concrete walls expose shifting shadows and reflect light with small silicate crystals embedded in the panels. These effects nudge the body to move along the building, or in and out through its glazed facades. Times Square now has small reflectors set into the landscape of its new pedestrian plazas. These promote new types of movement through the space and through the city.

Human nature has changed little in millennia and certain core aspects of what it is to be human

will likely remain for generations to come. Because of this it is possible to explore the core aspects of light and how they affect us. In a sunny climate it may be that the tiniest shaft of light through the trees or a tent cover that provides the paradigm for appreciating these relationships with the sun, in a darker place it might be a reflection from the rain. But the vitality of light is so important to us that it cannot be ignored.



THE RHYTHM OF ETERNITY

Photography by Ole Christiansen

“You would say, would you not, that the sun is not only the author of visibility in all visible things, but of generation and nourishment and growth, though in itself the sun is not generation? ... In like manner the good may be said to be not only the author of knowledge to all things known, but of their being and essence, and yet the good is not essence, but far exceeds essence in dignity and power.”

Socrates in: Plato, The Republic, Book VI, 509b





“If there is no reason to hinder and the choice is free, the temple and the statue placed in the cella should face the western quarter of the sky. This will enable those who approach the altar with offerings or sacrifices to face the direction of the sunrise in facing the statue in the temple, and thus those who are undertaking vows look toward the quarter from which the sun comes forth ...”

Vitruvius: Ten Books on Architecture, Book IV, Chapter V







“The Acropolis has turned me into a revolutionary. It has become a decisive voice of my conscience: always think of the Parthenon, precise, succinct, intensive, economic, overwhelming, a strong sound, a powerful call that is sent out into a landscape full of grace and horrors, an epitome of power and purity.”

Le Corbusier, speech at the 4th Congress of Modern Architecture (CIAM); Athens 1933





QUO VADIS, DAYLIGHTING?

The future of a vital resource

New research, new metrics and planning tools, as well as technological innovation are currently driving change in daylight design. On the occasion of the 6th VELUX Daylight Symposium in London, it is time to draw some interim conclusions: what factors have the potential to create lasting change in daylighting design? And what will have to happen if the benefits of daylight are to receive not just verbal praise, but be harnessed in all buildings to their full extent? On the following pages, twelve leading daylighting experts – scientists as well as practitioners – have answered these questions. More contributions can be found on www.thedaylightsite.com.

Photography by Thekla Ehling





“It is not an exaggeration to say that we can make the world a better place, where every space can bring out the best from people – the best work from employees, the best health care from our nurses and doctors, the best behaviour from our children in school – by providing spaces in which daylight stimulates and delights. Do we accept that challenge?”

Jennifer Veitch

Let daylight bring out the best from us

THERE HAS NEVER been a more exciting time for people who care about light in buildings, whether they are scientists, designers or building inhabitants. We are learning more about how light (and dark, in its place) influence human experience than we had ever imagined, and we have amazing new technologies to help us engage with light in ways we had not previously imagined. UNESCO timed it right in naming 2015 as the International Year of Light and Light-based Technologies.

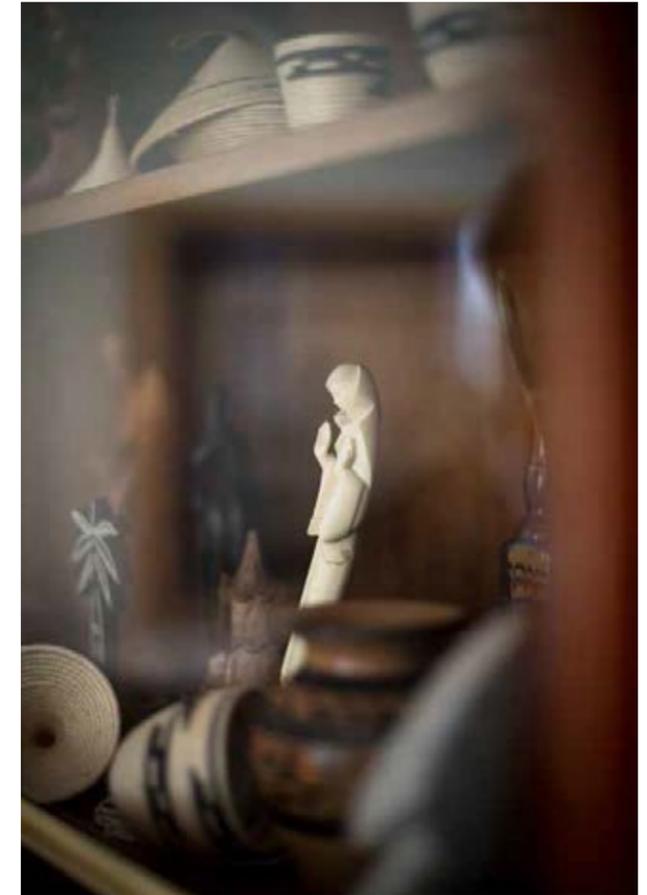
I'm a scientist, so I think of that first. Not long ago, we believed that rod and cone photoreceptors were solely responsible for physiological responses to optical radiation. Most lighting research focused on visibility, with preventing immediate discomfort from glare as a secondary topic. At the turn of the 21st century, we learned that a separate class of cell in the

eye sends separate signals about the presence of light for the purpose of regulating circadian (daily) cycles. Only a decade ago came the first consensus report about healthy lighting, setting out as principles the idea that common daily light exposures in developed countries are too low, and that healthy light exposure each day includes regular periods of darkness. Lately, we have begun to learn about other neural pathways through which light influences behaviour and well-being, some of them immediately following exposure, some after a time delay, and others in recurring patterns. Our scope as scientists has broadened to encompass well-being in all its aspects.

Making good use of daylight flows from the principles of healthy lighting¹: daylight is available at the times of day when most people need it, is abundant,

requires no electricity for its production, and is rich across the visible spectrum. Its variability across the day, over the seasons, and in response to weather, adds interest that stimulates and information that keeps us connected to the world around us. When we further consider the strong evidence for health and well-being benefits that flow from access to nature, the case for good daylighting in buildings seems unassailable.

Those concerned with thermal performance of buildings might differ with that assessment; there is pressure from that community to limit glazing area in order to provide better insulation and to meet targets for whole-building energy performance. Fortunately for everyone, the development of new technologies is addressing this problem. We can make better use of daylight by using redirect-



ing systems on windows to put light deeper into the building and to reduce glare; we can use skylights, rooftop collectors, and side-lighting collectors to provide daylight throughout the space; new films, gas fills, and glazing systems can improve the thermal performance of windows. Dynamic glazing systems can provide glare control, and integrated controls can ensure that electric light is used only as and when daylight is insufficient. Integrated solar energy systems can ensure that the advanced glazing does not consume energy, and offers the potential for contributing to electricity generation in an energy-positive (or at least net-zero-energy) building. In the coming years there will be fewer reasons not to provide good access to daylight, and more reasons to ensure that everyone has daylight exposure when they need it.

The potential is tremendous – but how can we harness this? The accepted wisdom is that if only we could demonstrate the financial return on investment of better daylighting, the case would be made. If companies knew how their staff could produce more creative ideas, provide better customer service, and be in better health, of course they would invest in

beautifully daylight spaces with integrated controls – wouldn't they?

We do need those demonstrations, partly to help in the decisions and partly to provide guidance concerning exactly which daylighting solutions deliver the right light exposures. Although this evidence is a necessary condition for better use of daylight in buildings, it is not sufficient. Good daylighting solutions demand an integrated building design approach in which the thermal and daylighting decisions are taken in concert from the start of the design process, and in which at least preliminary lighting design and control considerations are built in. Integrated design is not itself a new concept, but it does not seem to me that we are yet at the point of that being the default design approach, except perhaps at the highest end of architectural work.

This is a time of opportunity, if we who care about daylight in buildings can bring together all of these developments. It is not an exaggeration to say that we can make the world a better place, where every space can bring out the best from people – the best work from employees, the best health care from our nurses and doctors, the best behaviour from our chil-

dren in school – by providing spaces in which daylight stimulates and delights. Do we accept that challenge?

© 2015, National Research Council of Canada

Jennifer A. Veitch, PhD, is a Principal Research Officer at the National Research Council of Canada, where she has led research into lighting effects on health and behaviour for over 20 years. She serves CIE (the International Commission on Illumination) as Director of its Division 3, Interior Environment and Lighting Design. Jennifer Veitch is a Fellow of the Canadian Psychological Association, the American Psychological Association, the International Association of Applied Psychology, and the Illuminating Engineering Society of North America.

Note:

1. Commission Internationale de l'Eclairage (CIE). (2004/2009). Ocular lighting effects on human physiology and behaviour (CIE 158:2009). Vienna, Austria: CIE.





“Daylight is not a driver for change per se, but a fundamental phenomenon faithfully assuring continuity – the steady regularity of day and night, of dawn and dusk, of light and darkness, which affects all human behaviour.”

Marc Angélil

Pas de trois

CONSIDER THE *pas de trois* between daylight, architecture and people as a choreography of relationships and movements in time. The three protagonists engage less in a *ménage à trois* than in a kind of dance of mutually interactive associations, one supporting the other in an endless play of visual relations, atmospheres and emotions. It was Le Corbusier, as a matter of fact, who considered architecture to be not only a ‘*machine à habiter*’, but also a ‘*machine à émouvoir*’ – an apparatus for living as well as one that could touch the senses. Daylight, as he assertively argued, is paramount to any comprehension of architecture, which he defined as “the masterly, correct and magnificent play of masses brought together in light.” Without daylight, no architecture. And here, another ‘machine’ comes into play, a *deus ex machina*, so

to say, of cosmic promotions, reliantly commanding the movement of planets circumscribing the sun, whilst establishing the cyclical measure of life. At this junction, chronobiology enters the game with its circadian rhythm, determining physiological processes in all living organisms, including the human species. Daylight, in this particular respect, is *not* a driver for change per se, but a fundamental phenomenon faithfully assuring continuity – the steady regularity of day and night, of dawn and dusk, of light and darkness, which affects all human behaviour – a continuity, though, with subtle changes that only fully come to fruition when exposed to the material world, at the very intersection between the immateriality of light and the materiality of architecture. Space comes to life when touched by light; for daylight transforms,

like the kiss in fairy tales, raw materiality into architecture – a ‘machine’ of sorts for moving emotions.

Dr Marc Angélil is a professor at the department of architecture of the Federal Institute of Technology (ETH) in Zurich, Switzerland, and a founding partner of the office agps architecture in Zurich and Los Angeles. In 2014, he was Chairman of the Jury of the Swiss VELUX Stiftung’s Daylight Award.

“Perhaps most importantly, scientific researchers will need to more clearly define the benefits of daylight on health, productivity and the environment if natural light is to re-establish itself as something of value within the current marketplace.”



Paul Rogers

Prioritise daylight – at all scales

IT IS GENERALLY understood that the use of daylight in buildings has the potential to both save energy and increase workplace productivity. In my opinion, however, the most compelling argument for daylight in buildings is its far-reaching benefits to human health and well-being. Though science still struggles to define the full benefits of natural light, I believe that exposure to daylight is a fundamental need we share as human beings. As such, it is our responsibility as building industry professionals to ensure that the occupants of our buildings are provided with ample opportunity to have meaningful contact with it.

Technology seems to affect every aspect of our lives, and our relationship with daylight is no exception. In the northern European context, the most significant technological development in daylighting is likely to be the continued improvement in the thermal performance of windows. We have seen a continuing tightening of energy regulations and it is almost certain that this trend will continue. To date there has been an almost myopic focus on reducing heating and cooling energy; the industry has responded with thicker walls, smaller window size, deeper floor plates and the use of reflective glazing. These practices, while effective in saving

energy, come at the expense of daylight. It is essential that window technologies continue to evolve so that reduced window size and glass with poor light transmission are no longer attractive strategies in the quest to save energy.

If we are ever to realise the full potential of daylight, however, technology itself is not enough. We also need to revisit past notions on how we design not only our buildings but also our cities. Prior to the 1970s, daylight was essential to both architects and planners. Over the past century, our reliance on electrical lighting has increased and this has allowed the industry to commonly prioritise a full list of criteria ahead of daylight. In recent years, even aesthetic concerns have been allowed to compromise our basic access to daylight. Increasing urban density is another particular challenge to daylight access. Perhaps most importantly, scientific researchers will need to more clearly define the benefits of daylight on health, productivity and the environment if natural light is to re-establish itself as something of value within the current marketplace.

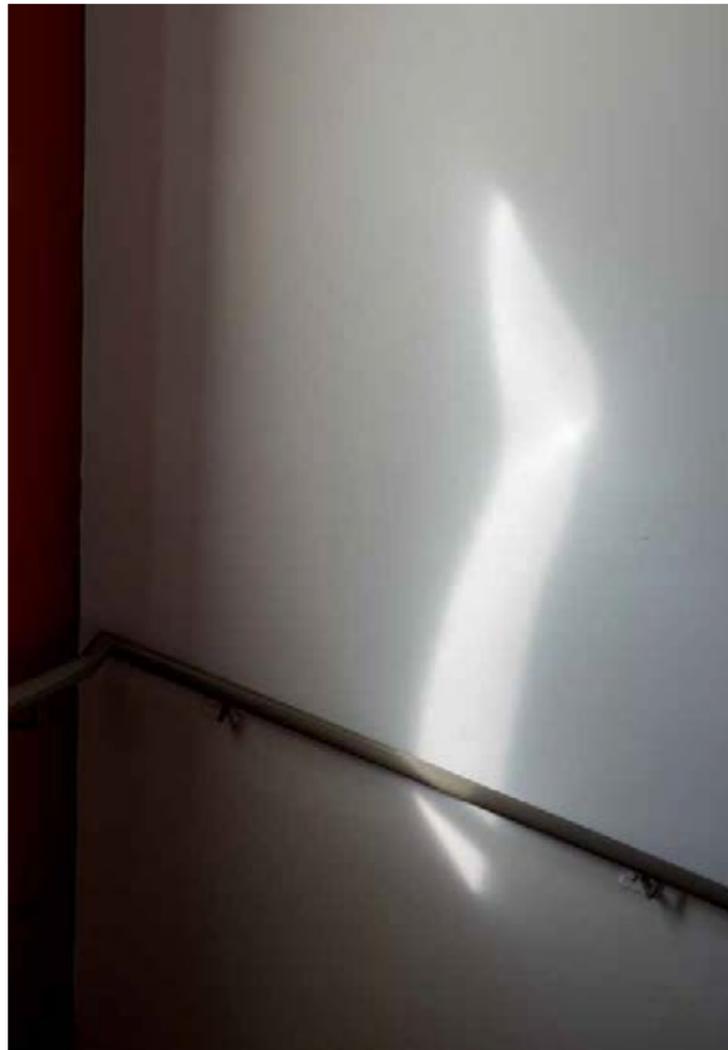
Despite the fact that daylight has the capacity to improve our lives, it is something that perhaps few of us ever consider. Like most issues of importance, raising

people’s awareness about the subject can only be a benefit. Of course, designers and planners need to be made aware of how their design decisions affect daylight. Daylight simulation tools are becoming more accessible and can help to this end. Legislators have a key role to play as well. However, it is the building users who, through increased awareness, have not only the power to enact change but also the most to gain from it.

Paul Rogers is an architect at BAU Architects in Stockholm, Sweden. He specialises in daylight certification and is founder of ‘Svensk dagsljusberäkning’ (Swedish daylight calculation) with more than 200 members on LinkedIn. Along with select members of this group he is helping the Swedish Building code authorities modernise the country’s daylight regulations.



“The challenge is to rediscover how the path of the sun shapes our life and experience, and apply this lesson to urban planning and building design from first principles.”



Francesco Anselmo

Design with sunlight first

CAN WE IMAGINE a house without windows? Probably not, yet we don't seem to mind spending most of our lives in artificial environments, working, studying, meeting, shopping deep inside buildings where air and light are crafted by machines to create the most uniform and stable conditions.

We've strived to create the perfectly stable environment at work to avoid distractions and enhance productivity. These conditions are sanctified by design recommendations, building regulations and energy codes, which have been put together, in bona fide and with the best intentions, to improve living and working conditions and environmental footprints. Yet the most basic rule of providing natural light for all is seldom applied and perceived as conflicting with energy-efficient design.

Artificial, electric light is efficient and cheap. With it, we humans have conquered the night. With it, we can extinguish the darkness lurking inside the deepest rooms. With it, we are witness-

ing the transformation of our cities into denser environments with ever larger and deeper buildings designed to maximise economic profit whilst preserving energy, therefore keeping solar radiation out.

Views out increase the value of a property, so glass surfaces have become pervasive. But does a fully glazed facade mean more daylight? Fully glazed facades must still keep the heat out, transforming glass into a highly technical material capable of reflecting more sunlight and solar heat, sometimes even with negative effects on the neighbouring environment. Fully glazed facades must minimise glare, and typically include add-on manual shading devices that are typically deployed and forgotten in the down position.

Sunlight seems to have become the worst offender, even in cloudy and cold countries. But we have forgotten that this is the light we have evolved with, the light that has shaped life on Earth and that sustains it day after day. The light that, when filtered through the canopy of a forest, creates the most perfect envi-

ronment we have known for millions of years. But it is also the very environment we have just started to reject because of our current social, political and economic infrastructure, which makes us migrate at increasingly faster speed to the megacities of the 21st century.

The challenge for new generations of building designers is to think about the human sensorial experience and the fundamental role that sunlight has had in shaping our early cities and buildings. The challenge is to rediscover how the path of the sun shapes our life and experience, and apply this lesson to urban planning and building design from first principles.

Design with sunlight first.

Francesco Anselmo is a Senior Lighting Designer at Arup in London, where he has specialised in numerical simulation and visualisation systems and develops computer tools for lighting design, building simulation and interaction design. He holds a PhD in Environmental Physics and a degree in architectural engineering.

Learn to design – with light

IN RECENT YEARS, the interest in daylighting has experienced an unquestionable growth, not only among architects but also among the general public. At the same time, many people are also pursuing a healthier lifestyle, caring more about their bodies and their nourishment. If this weren't true, how else could we explain the success of fitness centres and natural foods? In my opinion, this is a direct consequence of the saturation of the model that I call "artificial life", which has become so widespread from the mid-twentieth century onwards, and has included numerous everyday practices that encouraged the non-movement of the body. After all, cars are there to be used! Why should we lose time with a meal? Fast food is so versatile! And, related to buildings, why daylighting? Technology can provide all the light we desire, at a low cost. Why bother with environmental questions? Mother Nature is so generous!

Such thoughts were commonplace in the second half of the 20th century but, nowadays, increasingly appear outdated. Besides the well-known effects related to energy saving, other important benefits of daylight in buildings are being recognised, such as visual contact with the outside and its stabilising effect on the circadian rhythm. This is due to the spectrum of daylight, which is the only one that is completely adequate for humans when compared with other, man-made sources of lighting.

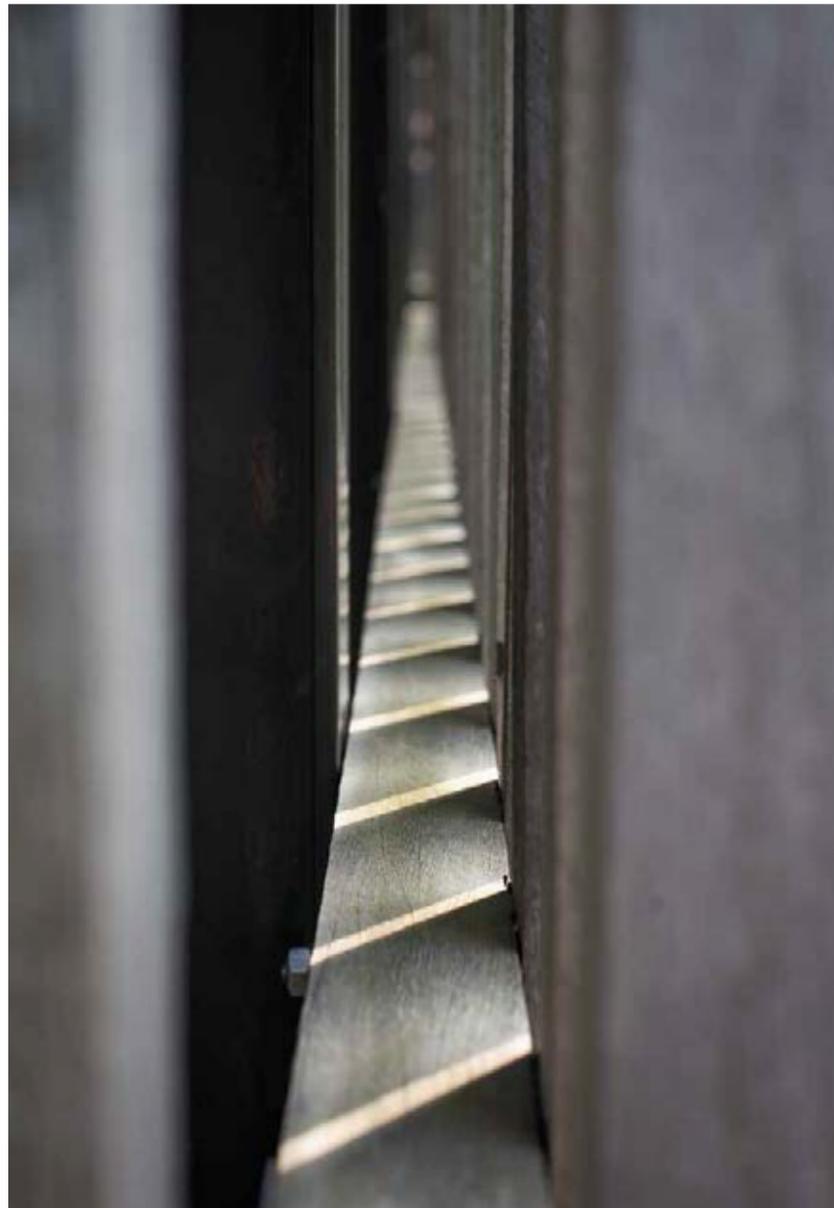
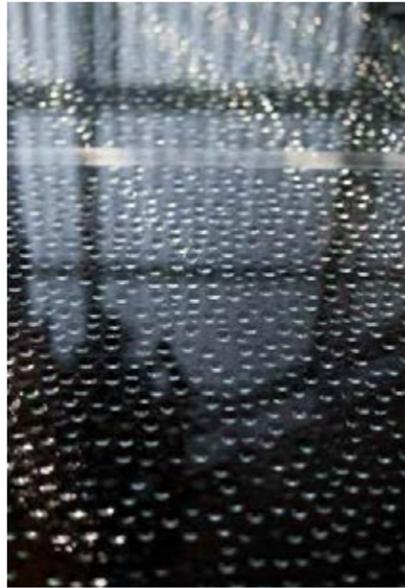
The renewed general interest in daylighting has motivated new research projects and prompted the development of new products that are slowly changing the manner in which buildings are conceived. Increasingly, the dynamic properties of daylight are now already considered in the design process of buildings, in a manner that was unimaginable until a few years ago. Numerous new products and devices for improved daylighting in buildings are now available. But the greatest contribution to a new way of designing buildings

will come from a better comprehension of the non-visual effects of lighting, which are still not fully understood by scientists. This is the scenario we are currently facing: a growing interest in daylighting, the recognition of its importance, plenty of new research related to the theme, new concepts and tools for daylighting design, as well as new products that have become available. But things are not quite as simple as they seem. Unfortunately, a significant part of the new developments is still restricted to the realm of researchers and specialists, and tends to be considered merely an ephemeral 'fashion' by laymen. So to ensure that we harness the full potential of daylight in future buildings, we must first educate the future generations of architects, showing them that it is possible to design with daylight, and teaching them how to do it.

Architects are primarily visual beings; hence visual stimuli should primarily be used to introduce them to daylighting. Looking at drawings, photographs – including HDR (high-dynamic range) imaging – and physical scale models are excellent for this purpose. Such exercises teach us to see, which is a condition *sine qua non* in order to understand lighting as a three-dimensional element of the architectural space. Once this has been achieved, it will be relatively simple for students also to get acquainted with the most relevant daylight calculation methods and lighting standards, as well as software programs for daylighting design and simulation.

Prof Dr Paulo Scarazzato is a Brazilian architect and lighting designer who teaches at the universities of São Paulo and Campinas. In addition to residential, industrial, commercial and religious buildings, his professional portfolio also includes lighting projects in heritage listed buildings as well as hospitals and transportation interchanges. Paulo Scarazzato is a member of the Daylighting Committee of the Illuminating Engineering Society of North America (IES) and sits on two technical committees of the Commission Internationale de L'Éclairage (CIE).





“The character of daylight is not the same in the north as it is in the south. The two types of light must be treated differently in the design of daylight apertures in buildings if we want to harness the local daylight in an optimal way.”

Nanet Mathiasen

The genius loci of daylighting design

MANKIND EVOLVED underneath the sky of the Earth. Hence our species has always existed in close relation to the particular light there is on the surface of our planet. Much research in recent years points to how important it is for us to be exposed to daylight in order to exist and to feel well. Therefore the straightforward conclusion often is to ask for as much daylight as possible to light up our interiors. The more light the better.

But quantity and quality are not always the same. A lot of light does not automatically make for an agreeable and well-functioning visual environment. So new questions arise: how to light up interior spaces? How can we benefit from the qualities of daylight indoors, and how should daylight be transformed on its way into a building's interior?

Two aspects are of importance to answering these questions:

- knowledge about the characteristics of daylight, which vary depending on the latitude of the location
- understanding how to design light apertures that distribute light efficiently in the interior and, at the same time, create a high-quality visual environment.

The character of daylight is not the same in the north as it is in the south. We all know this from travelling abroad. Daylight varies not only throughout the day and the year but also according to latitude. These fluctuations create the local daylight characteristics and contribute to the 'poetry' of a place. The delicate pale Nordic light, with its variations in whiteness and shades of grey, is the complete opposite of the bright Southern light, where large contrasts between light and shadow are a typical feature. The two types of light reveal architecture in different ways and thereby create different environments and atmospheres. Therefore they must also be treated differently in the design of daylight apertures in buildings if we want to harness the local daylight in an optimal way.

Vernacular architecture is often referred to as 'custom designed' according to local climate and daylight. In the same spirit, the knowledge mentioned above could be a driver for change in building design, converting the traditional facade windows into daylight apertures that carefully respond to local daylight conditions, and enabling architects to design beautiful, well-lit spaces that human beings will feel comfortable in.

Nanet Mathiasen trained as an architect and has been a teacher and researcher at the The Royal Danish Academy of Fine Arts Schools of Architecture, Design and Conservation. She has recently submitted her PhD thesis *Nordic Light and its Impact on the Design of Apertures in Nordic Architecture*, and has started working for the Danish Building Research Institute at Aalborg University.

Towards new metrics for better daylighting

THE DESIRE FOR DAYLIGHT indoors serves as a constant reminder that – notwithstanding our remarkable technical accomplishments – human beings are, constitutionally, ‘outdoor animals’. This is hardly surprising given the timescales over which evolution occurs, but easy to forget given the rapid pace of technological progress. Buildings have long provided shelter, but it is only relatively recently that we have become accustomed to spending the majority of the daylight hours indoors. The economic imperatives followed in the 1950s led to very deep-plan, side-lit office spaces – effectively windowless for the majority of occupants. These were eventually shown to be unsustainable for a variety of reasons: social, psychological and, not least, economic. Workers in such spaces – disconnected from the outside – appeared to perform less well than their competitors who had better daylight and views, i.e. with better ‘connection’ to the outside. Daylight provision for the workplace and schools is now ‘hot topic’ – but what of daylight in the home?

The 2012 Future Homes Commission survey showed that “63% [of potential UK house-buyers] rated natural light as the most important aspect of a home”. A need that many (in the UK at least) feel is not being met by much of the modern housing stock on the market. For some housing developers, the energy/carbon reduction imperatives are interpreted as dwellings needing smaller rather than better windows. It would be an unfortunate irony if the goal of protecting the natural environment resulted in dwellings where the occupants became more disconnected from the (outdoor) environment we are trying to protect. The daylighting properties of a residential dwelling depend on: glazing configuration; aspect/orientation; space layout; wall thickness; overhangs/obstructions and site context – in addition to the glazing area, which is often the

“In order to satisfy both energy reduction directives and need for connectivity to the outdoors, we need better rather than smaller windows for our dwellings.”

sole consideration for simplistic energy-based evaluations. In order to satisfy both energy reduction directives and need for connectivity to the outdoors, we need better rather than smaller windows for our dwellings. And there needs to be greater thought given to the arrangement of the windows and their integration with the building envelope. In short, the daylighting design of residential buildings should be a key consideration for developers – the house buying public (in the UK) have made that very plain.

The daylight metric best suited to the evaluation of residential buildings is currently a matter for debate. Contenders include useful daylight illuminance (UDI) and spatial daylight autonomy (SDA). Because the potential for sunlight to directly illuminate a room is an important consideration for dwellings, a ‘sunlight beam’ metric could be an effective complement to absolute illumination metrics such as UDI or SDA. This summer, a new schema to precision-quantify the annual sunlight beam potential of window apertures was presented for the first time at the 28th Quadrennial Session of the CIE in Manchester, UK.

The new schema aims to provide a methodology to answer the not-so-simple question: how much sunlight can enter a room? The measure proposed is the cross-sectional area of a sunlight beam

that: (a) passes through a window; and (b) enters the main volume of the internal space. The new measure – called the sunlight beam index – is determined for a full year on a timestep basis (e.g. every 15 minutes) but it can be aggregated into monthly or yearly totals. The annual total provides a single measure for: one window; a group of windows; or all the windows for an entire dwelling.

The new approach will of course need to be scrutinised and tested using real-world examples. What is not in doubt is the need for a meaningful assessment of the daylight/sun potential of residential dwellings, using measures that can be readily understood by both homebuyers and developers alike.

John Mardaljevic (PhD, FSLL) is Professor of Building Daylight Modelling at the School of Civil & Building Engineering, Loughborough University, UK. He pioneered what is now known as Climate-Based Daylight Modelling (CBDM). Founded on rigorous validation work, Climate-Based Daylight Modelling is now the basis for research and, increasingly, industry practice worldwide. John Mardaljevic currently serves as the ‘UK Principal Expert on Daylight’ for the European Committee for Standardisation CEN/TC 169 Work Group 11, and on a number of technical committees of the International Commission on Illumination (CIE).





Focusing on people: with clear priorities towards better architecture

EVOLUTION HAS conditioned human beings to flourish in daylight. This is borne out by many involuntary functions we are unable to influence, such as the automatic adjustment of our eyes to brightness, distance and colour, our circadian rhythm of day and night, and, not least, the production of vitamin D through exposure of our skin to sunlight, an essential process for the regulation of bone growth and calcium levels in blood. Furthermore, the uplifting spirit that we all feel on a sunny day also testifies to the psychological importance of bright daylight.

But as we are now spending more and more time indoors, every effort should be made to allow daylight to be experienced in its most natural form inside buildings as well. Unfortunately, there has been no significant progress in the development of systems for daylighting, i.e. building elements that (at least in our latitudes) transmit as much diffuse natural light as possible to the inside of buildings while avoiding direct sunlight.

This can probably be attributed to the fact that, in order to effectively exploit existing natural light, such systems essentially have to be optimised and adapted to every individual building. Any change in the alignment of a building, even on the same site, will require a different strategy for shading or directing light to the inside. It is this circumstance that prevents any large-scale production of these systems that would lead to a necessary and desirable reduction in costs, allowing such systems to become more widely available.

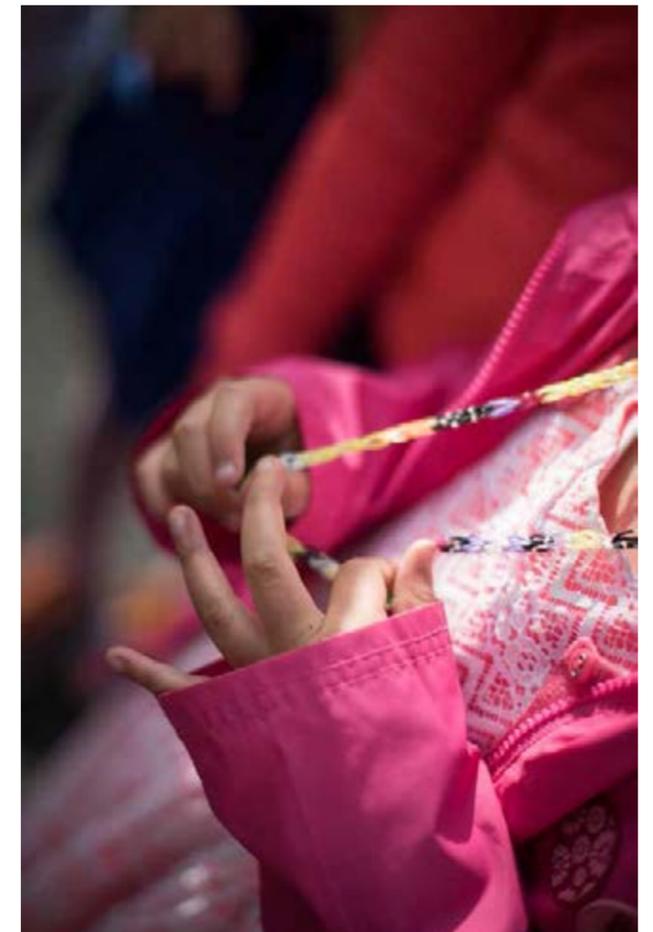
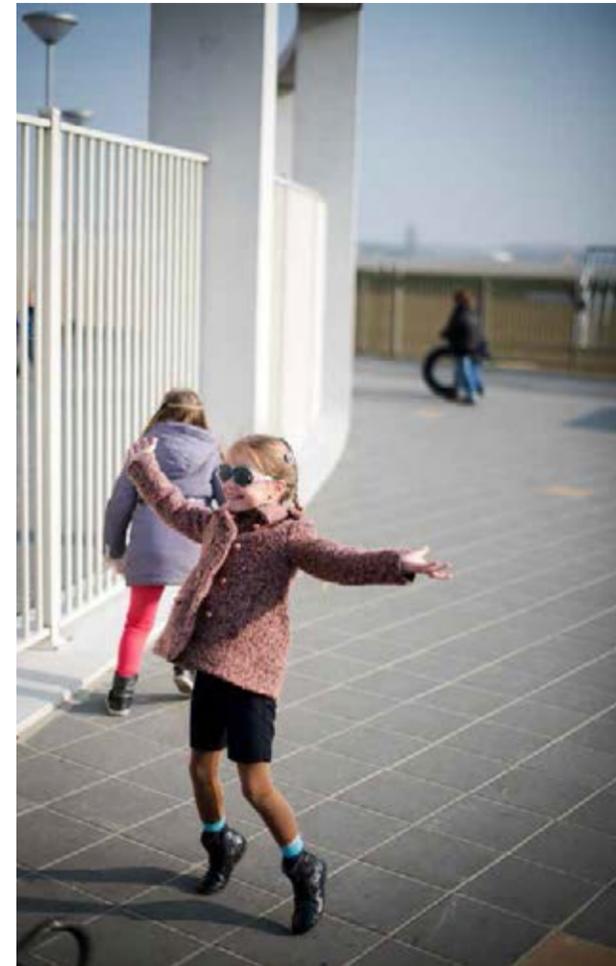
This problem is compounded by the notion of 'energy conservation at all costs,' formulated with no clear concept: designs for new buildings and for converting old

ones rely heavily on energy-based considerations to justify the use of triple glazing. But this is a misconception that ignores the corresponding rise in the amount of artificial lighting required due to the reduced influx of daylight. And planning almost never takes account of the fact that triple glazing disproportionately filters out certain parts on the extreme edge of the visible spectrum (ultraviolet and infrared light), which recent medical opinion considers to be very important for health.

From all of these observations it follows that we need an architecture that knows how to provide enough daylight while offering protection against overheating using cost-effective 'low tech' solutions. 'Myopic energy conservation' needs to be replaced by 'real efficiency,' defined as achieving a worthwhile goal while conserving a maximum of resources.

A worthwhile goal must be to create the best possible lighting environment for the people who work, live and relax in a building. Exploring such interconnections in more detail and imparting the knowledge to budding architects should be our most urgent task.

Prof Peter Andres set up his own lighting design company in Hamburg in 1986 and opened a branch office in Tirol in 2001. Peter Andres has been honorary professor at the PBSA Peter Behrens School of Architecture, University of Applied Sciences in Düsseldorf since 2006. He received the award "Lighting Designer of the Year" in 2012, and in 2013 he was awarded the German Lighting Design Awards prize in the category 'Education'. Projects carried out by his company include the daylighting design for the VELUX LichtAktiv Haus in Hamburg.





Anna Pellegrino

Creating change through daylight

DAYLIGHTING HAS ALWAYS been an essential and irreplaceable resource in the field of architecture.

It can be considered a resource from a design perspective, since it contributes significantly to the character and appearance of indoor spaces in buildings, due to such features as quantity, distribution and direction, through effects of light and shadow, and as a result of its variability in space and time.

It is a resource from an economic perspective, since daylight availability and the quality of daylighting design contribute to the economic value of buildings, whilst the quantity of daylight available during the occupancy hours of spaces leads to a reduction in the use of electric lighting and consequently in energy costs.

But natural light is also a resource for the people who use the buildings. A daylit luminous environment and the presence of openings towards the outside are essential for the health and well-being of the users, from both a physiological and a psychological point of view. The beneficial effects of views outside include eye relaxation, perception of the flow of time, spatial relation to the outdoor context, and many more. Furthermore, the intensity, spectrum and variability of daylight can positively affect human circadian rhythms and reduce seasonal affective disorder.

Daylight can also affect productivity and comfort when carrying out visual tasks. In terms of visual comfort, it leads to both benefits and drawbacks. The large amount of light that can reach the workplane, its high colour rendering and spectral variability are generally perceived as benefits. Conversely, the high luminance of daylight sources can produce direct glare or reflected glare on glossy surfaces.

Given all its benefits, daylighting is a fundamental part of sustainable architecture, and new developments in daylighting research and technology are influenc-

ing the way buildings are being made or will be designed in the future.

One development area concerns the metrics adopted to assess daylighting. Since the beginning of the last decade, climate-based metrics have been proposed to take into account the annual daylight potential of a building. In 2012, the Illuminating Engineering Society of North America (IESNA) proposed two new metrics to assess indoor daylighting performance: spatial Daylight Autonomy (SDA), which indicates the percentage of area in a room where the illuminance by daylight alone is ≥ 300 lux for at least 50% of the time; and Annual Sunlight Exposure (ASE), which is an indicator of the potential risk of glare over the course of a year. It indicates the percentage of area in a room where the illuminance by direct sunlight is greater than 1,000 lux for at least 250 hours a year.

These two dynamic metrics have now been included in the latest version of the LEED program for green building certification (LEED v4). Furthermore, researchers are even trying to conceive new metrics that are based not only on visual comfort issues but also on non-visual effects of light or on aesthetic and perceptual aspects of illumination. For the future, the consolidation of effective daylighting metrics, which consider all the aspects related to daylight rather than just those based on workplane illuminance, will be essential for the overall assessment of building performance.

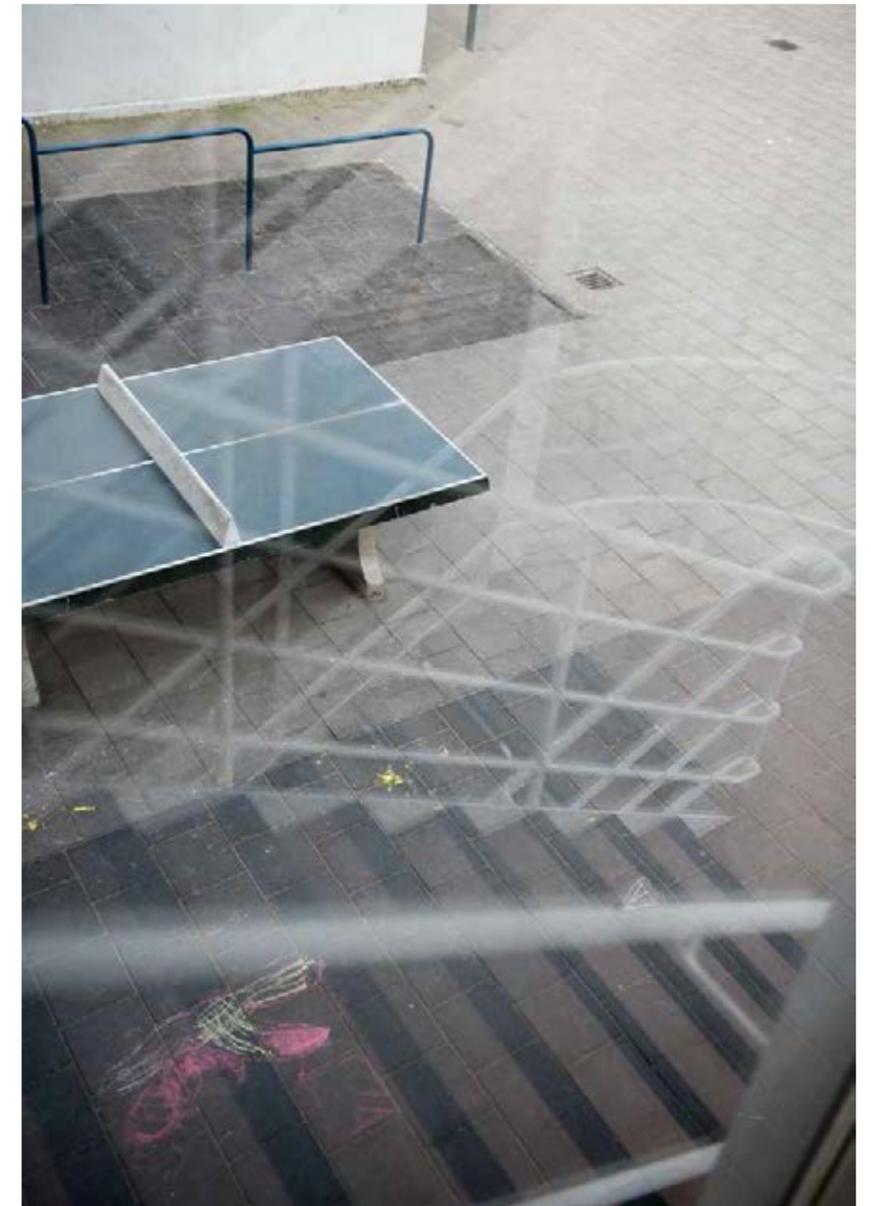
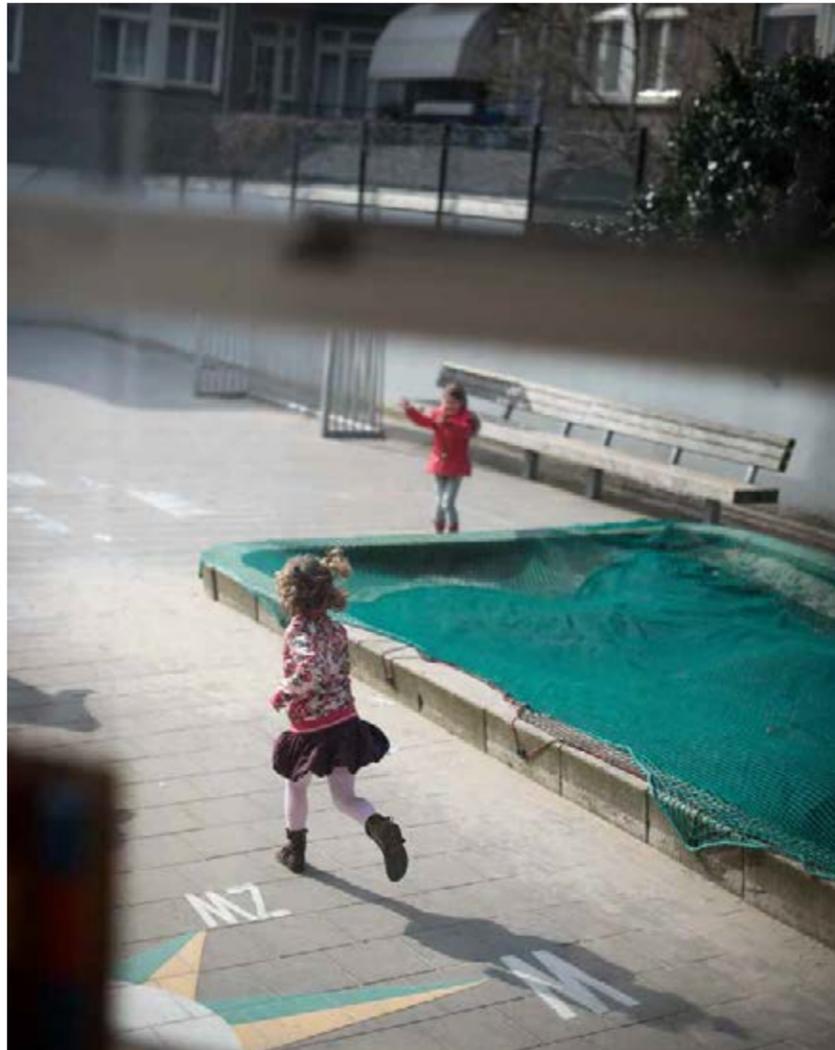
The development of technologies for building envelopes is another important driver of innovation related to daylighting. High-performance, transparent envelopes or building openings are being conceived to reduce energy loads and increase human comfort. These innovations are often associated with the concept of 'adaptive technologies', which can be active or passive, and generally influence both the thermal and visual

performance of buildings. Some examples are glazed facades with integrated, complex solar control components, passive daylight redirecting systems, phase change materials or even more traditional solutions such as electrochromic glazing, which is now undergoing a revival thanks to the potential size of the building retrofit market. In the case of complex systems, particular attention should be paid to their interaction with, and acceptability by, the user. This is another aspect that could influence the overall building performance to a great extent.

Although natural light has always been recognised as an inherent building material, new goals should be pursued in future buildings: daylighting for human health, well-being and space enhancement rather than only for proper workplane illuminance; daylight control for the optimisation of both visual and thermal comfort, daylight maximisation in order to reduce the overall (both electric and thermal) energy use in buildings.

All these aspects are already targeted in building design practice, but often at a late stage of the process and by different professionals or experts. Daylighting design should be approached in a more holistic way: developing solutions that are part of the architectural concept, while meeting visual, thermal and energy needs. Furthermore, daylighting should be a major focus area of the design process, right from the early stages, and should be comprehensively studied on all scales from urban design to building components.

Anna Pellegrino is an Associate Professor at Politecnico di Torino, Italy. She holds a degree in Architecture and a PhD in Energetics from the same university. Currently, Anna Pellegrino is a member of the research group TEBE (Technology Energy Building Environment; www.polito.it/tebe) at the Department of Energetics of the Politecnico di Torino. Her main research interests are all within the field of lighting: from lighting and control technologies to lighting applications and energy use, from lighting design to issues of light and health, visual comfort and material damage.



“The best way to achieve this change is through development of distributed intelligence in the form of smart luminaires, windows and skylights that carry their own sensors as well as logic controllers that adjust operable components based on environmental conditions.”

**Konstantinos
Papamichael**

Better daylight through distributed intelligence

THE BENEFITS OF DAYLIGHT are many and their importance depends on the type of space. They include psychological benefits in terms of view and the connection to the outdoors, biological benefits in terms of support for circadian rhythms, visual performance benefits in terms of excellent (by default) colour rendering, as well as energy and economic benefits through the potential for reduction of electric lighting and HVAC loads.

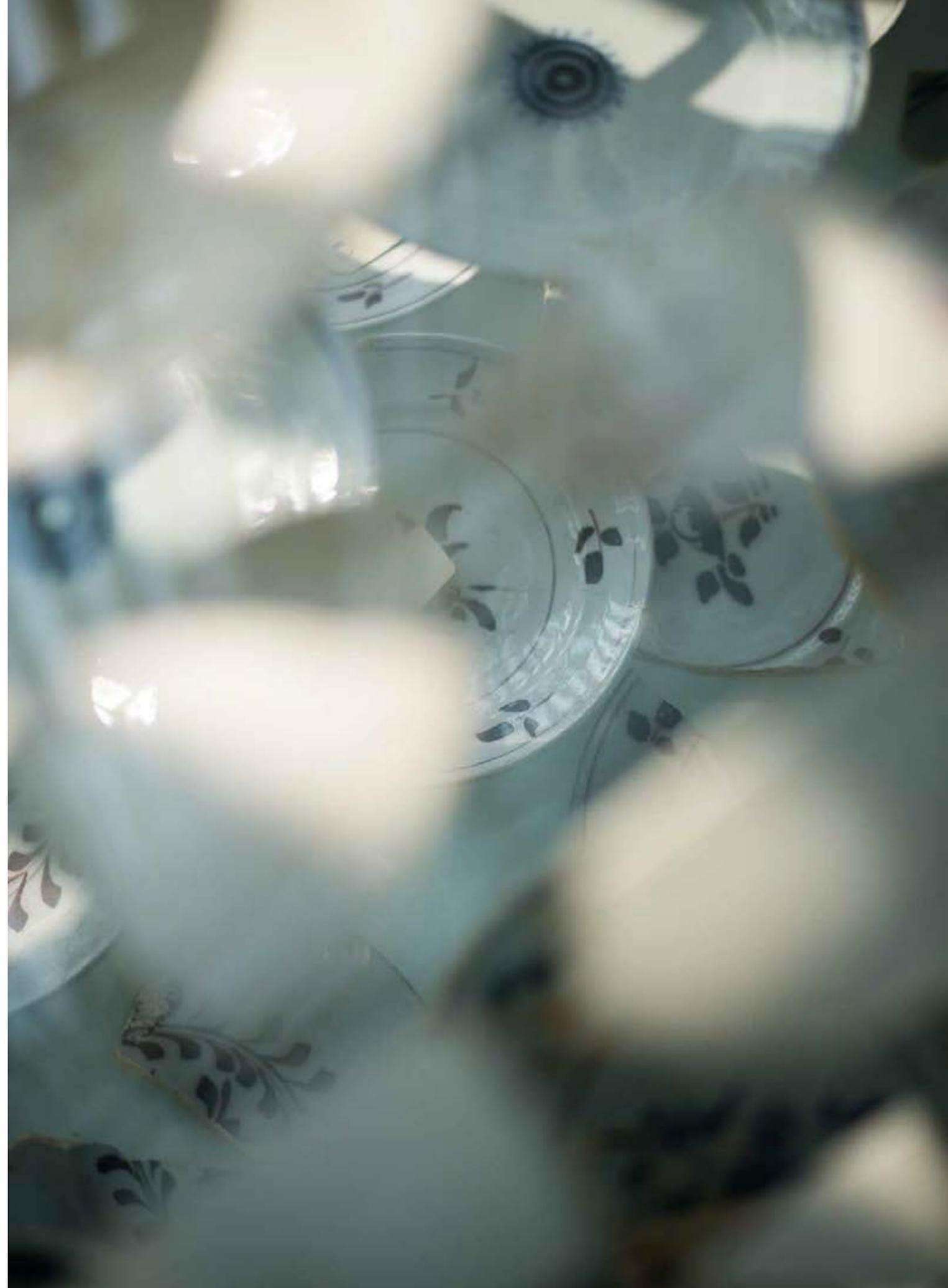
New developments in daylighting research and technology development are expected to have significant impact in the way we design buildings, aiming not only on visual but also on psychological and biological benefits. There are two main R&D areas that I expect will have strong impact. The first one is related to advancement in sensors, communications and controls, which will increase the reliability of automated electric lighting controls for daylight harvesting, and, most important, automated daylight management at the window and skylight level, based on sensing environmental changes indoors and outdoors. The second R&D area is in core sunlighting systems, which bring sunlight in the building core, i.e., in spaces away from windows and skylights, through sunlight collection, transportation and distribution systems.

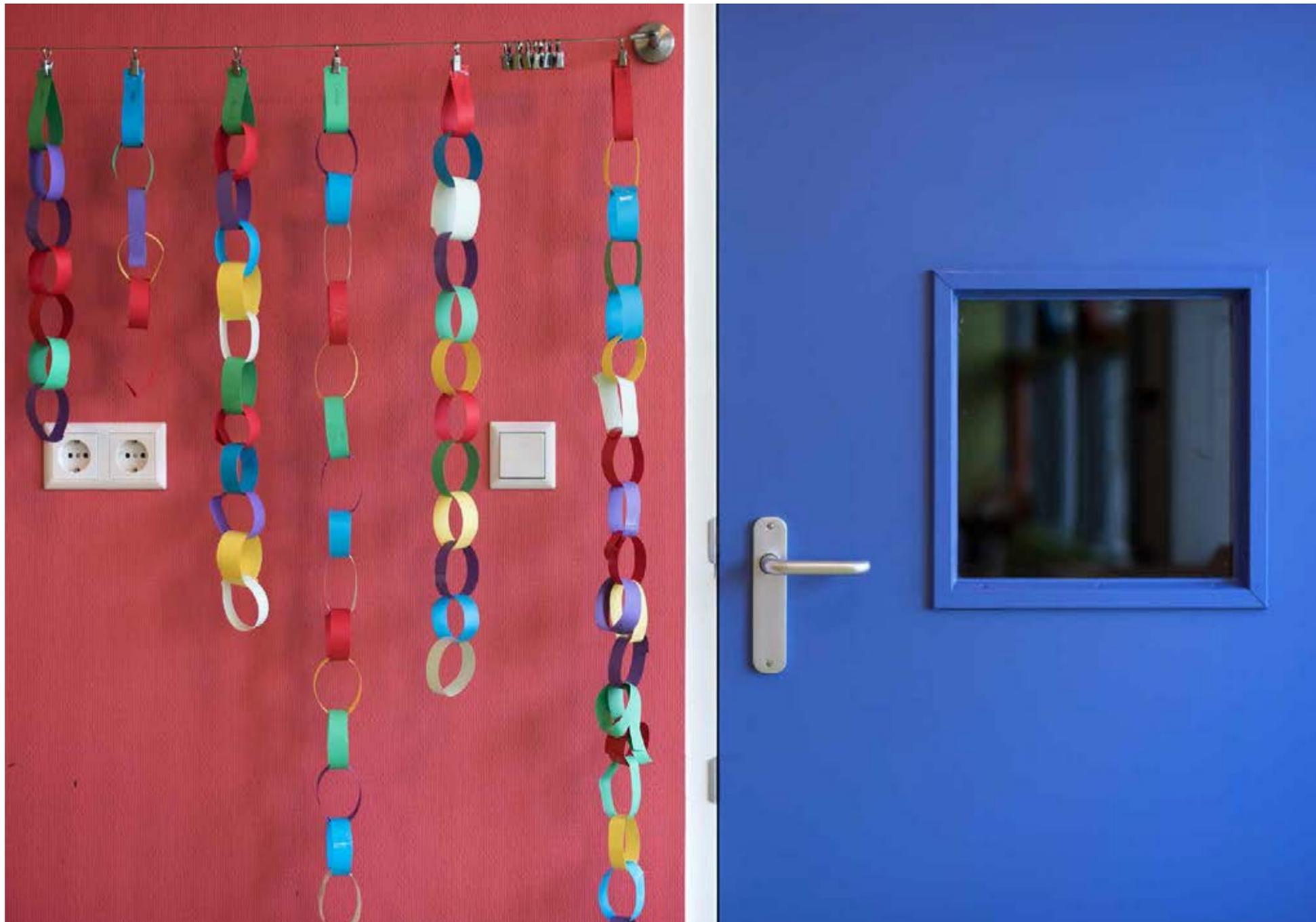
To fully harness daylight in future buildings, we need not only to increase the reliability and cost-effectiveness of electric lighting controls for daylight harvesting, but also to include daylight man-

agement through operable windows and skylights that automatically adjust their solar optical properties based on changes in their environment, to maximise performance in terms of comfort and energy efficiency.

I think that the best way to achieve this change is through development of distributed intelligence in the form of smart luminaires, windows and skylights that carry their own sensors (occupancy, light, temperature, wind, etc.) as well as logic controllers that adjust operable components to optimise performance based on environmental conditions, focusing on comfort during occupancy and energy efficiency during vacancy. Smart luminaires that communicate with each other have the potential to dramatically increase the reliability of electric lighting controls for daylight harvesting. Smart windows that communicate with electric lighting luminaires and HVAC systems have the potential to optimise performance in terms of comfort, energy efficiency and peak electricity demand reduction.

Dr Konstantinos (Kosta) Papamichael is a Professor in the Department of Design and the Co-Director of the California Lighting Technology Center at the University of California, Davis. He is a member of the US National Committee of the International Commission for Illumination (CIE) and the Chair of the Daylighting Committee of the Illuminating Engineering Society (IES), for which he led the development of the new version of the IES Recommended Practice for Daylighting Buildings.





DAYLIGHTING AS A RESEARCH TOPIC situates itself at the interface between psycho-physiological and environmental factors. It brings together questions relevant to architectural design and building engineering, but also to human physiology and behaviour, which makes it both a challenging and essential aspect of how “performative” a space can be considered.

Can we better integrate the complexity of human needs in buildings into effective design and decision-making support for daylit spaces? How well a given space is daylit is, by essence, a multifaceted question. It is a key factor in how well any visual task will be performed and a main driver of occupant satisfaction regarding visual and thermal comfort (and hence energy consumption resulting from trying to meet comfort requirements). It has a strong impact on human health and well-being, a close association with (subjective) emotional delight and perceived quality of a space, and is highly dynamic and variable in nature resulting from a combination of predictable (sun course) and stochastic (weather) patterns. There is, as a result, a multiplicity of perspectives from which daylighting performance can – and should – be evaluated in building design. Through very different perspectives, ranging from task-driven illumination or comfort to human-driven health and perception, the architect is hence faced with multiple, highly variable criteria that can conflict but need to be brought together to lead to a satisfying solution.

What the numerous existing tools and approaches have in common is the aim of trying to either define or meet broadly acceptable (yet sometimes population- or condition-specific) target values so as to guide design towards objectively ‘better’ performance. Yet daylighting is known to be a field where no strictly defined numerical boundaries are enforced. There is a vast range of param-

eters and values that contribute to ‘good’ daylighting design and make absolute performance targets of questionable relevance. The question of “how good is good?” is indeed far from trivial with the multifaceted, highly variable nature of daylighting performance, about which people – occupants as much as designers – have highly diverging opinions.

Architectural design cannot be replicated by a well-defined computational process because optimisation does not respond well to the non-deterministic, ill-defined and unpredictable nature of the design process. Therefore, computer technology and its efficiency in comparing and testing options should be used to help designers fulfil their primary role, which is: to know what to look for.

The ‘human’ challenge at hand is two-fold. It comes from the human nature of the designer, which remains the main driver of a design process: the ultimate balance between multiple, often-conflicting criteria cannot solely be based on measurable parameters, thus the design process must remain non-deterministic. And it comes from the human nature of the occupants, which encompasses individual diversity and temporal variability: as we know, to feel comfortable in a daylit space can result in very different constraints depending on the time of day, the season and the location of the building. Furthermore, human factors will induce diverging preferences for comfort from individual to another. The necessary flexibility and dynamic response of design goals also applies to our cyclic physiological needs or to the ever-changing ambiance of a space that contributes so intimately to its uniqueness.

To more deeply embed the diversity and variability of human needs as foundational elements of daylighting design and put human occupants back at the core of the question, we need to reach out to other research fields, so as to bring new

“To more deeply embed the diversity and variability of human needs as foundational elements of daylighting design and put human occupants back at the core of the question, we need to reach out to other research fields, so as to bring new insights and a deeper understanding of how we interact with our environment.”

insights and a deeper understanding of how we interact with our environment:

- as human inhabitants of a living space who need to be in an environment conducive to health, and have physiological light exposure needs whose time- and spectrum-dependent non-visual effects we are only beginning to understand, thanks to recent findings in circadian photoreception research
- as users of a (work)space who perform a task for which comfortable visual conditions are needed, and behave dynamically in a space in which lighting must be well controlled as a key factor of workplace satisfaction and ergonomics
- as witnesses of a delightful space who want to enjoy it and seek to experience its choreography of geometry and light dynamics
- and so on.

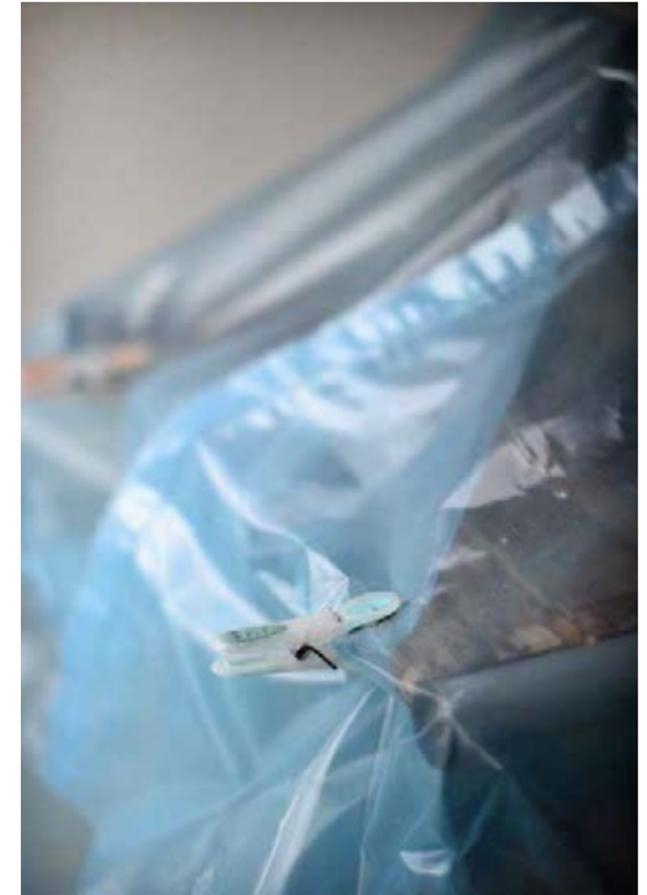
What we must identify is how a building should respond to two inputs: on the one hand to what we have, i.e. analysing the resources available to work with (i.e. the building's environment whether natural or built, its localisation, climate etc); on the other hand to what we need, to determine

whether and how the needs of the building's occupants can be met. The ultimate objective is to provide building designers with the means necessary to assess critical parameters in a successful design and efficiently combine qualitative and quantitative criteria in the solution search process.

A more comprehensive and extended version of this text has been published in the Fifty Year Anniversary Golden Issue for Building and Environment as: M. Andersen, Unweaving the Human Response in Daylighting Design, Building and Environment 91: 101-117, Sept 2015 (<http://dx.doi.org/10.1016/j.buildenv.2015.03.014>).

Marilyne Andersen is Full Professor of Sustainable Construction Technologies and Dean of the School of Architecture, Civil & Environmental Engineering (ENAC), at the École Polytechnique Fédérale de Lausanne (EPFL). She is also Head of the Interdisciplinary Laboratory of Performance-Integrated Design, whose research activities focus on building performance in the architectural context, and particularly on the use and optimisation of daylight in buildings.

Before joining EPFL, she was Associate Professor at the School of Architecture & Planning at the Massachusetts Institute of Technology (MIT) in Cambridge, USA, and Head of the MIT Daylighting Lab that she founded in 2004.



“We are human beings, we are a part of nature, and we have been, in a very basic way, conditioned by natural light and the natural landscape. Daylight, as well as access to views outside, is an essential part of our health – biologically, psychologically and spiritually.”

Vellachi Ganesan

Daylight – a perspective

THE MOST IMPORTANT benefit of daylight in buildings, in my perspective, is the connection of the inside to the outside. We are human beings, we are a part of nature, and we have been, in a very basic way, conditioned by natural light and the natural landscape. Daylight, as well as access to views outside, is an essential part of our health – biologically, psychologically and spiritually.

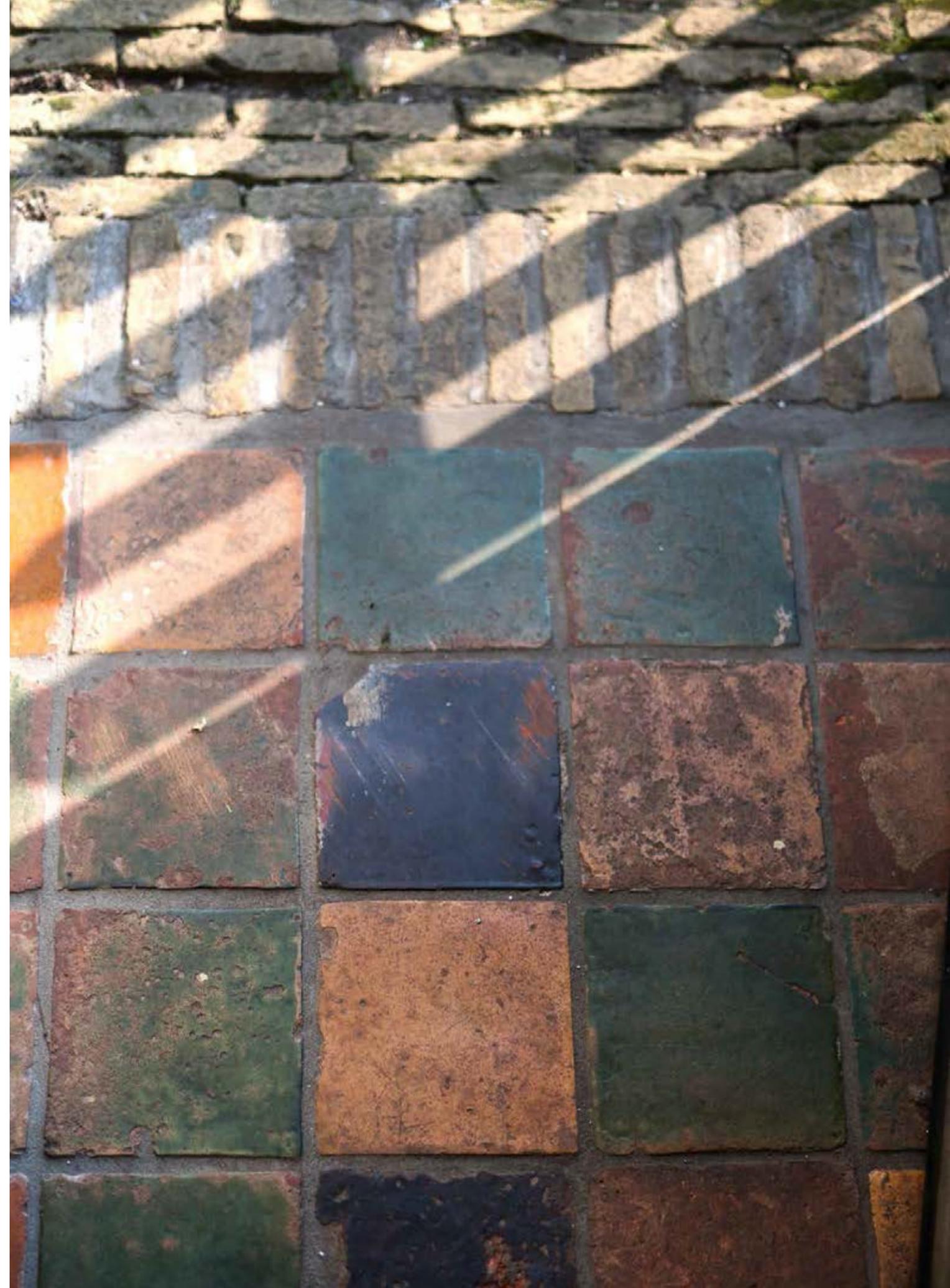
This our relationship with light has been an important part of our rich history of building, of our desire to incorporate openings into our buildings and of our drive towards technological progress that allows us to do so in increasingly sophisticated ways. As we extend the boundaries of building design, research in the area of new, smart building materials that transmit daylight is of utmost importance. These materials can be a game changer in defining what a window is in the future, and how the inside and outside are mediated over time in a building.

In our present design process, which is largely informed by sustainability models (including green building labels), there is a balance that needs to be struck between the extent of openings in a building (size, position, material, etc) and its thermal efficiency. With material that has greater thermal efficiency, levels of photosensitivity, and intelligence to change with the external climatic conditions, we will be able to bring more daylight into a building without compromising its thermal efficiency. These materials also need to be

developed to a point of economic feasibility and ease of use for mass integration into buildings.

Finally, with evolving technology, our perspectives, legislation and sustainability rating tools need to evolve further too, so as to be instrumental in creating architecture that is both sustainable for the Earth's ecosphere and energy resources as well as for human health. Strictly enforced quantitative evaluation sometimes results in designs that simply seek to meet numbers but, as a result, offer compromised quality of space to the human being. Rating tools need to evolve beyond this, into tools that inspire and enable design processes which result in more wholesome spaces. Truly sustainable building and healthy, nourishing architecture are but the same thing, and we need to recognize and validate this.

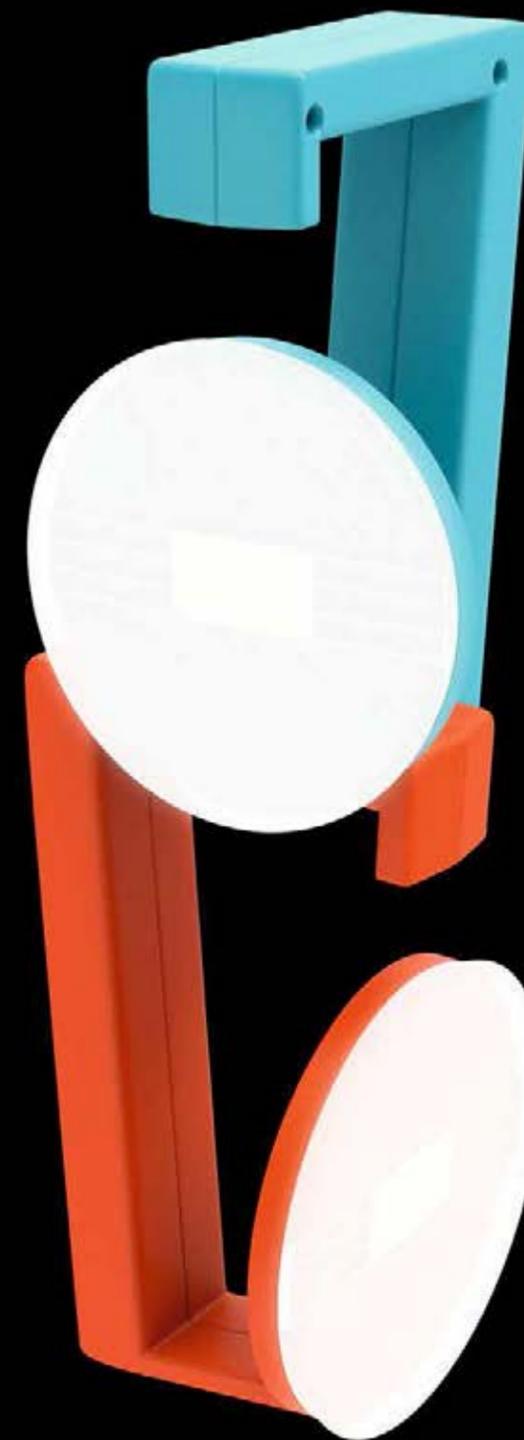
Vellachi Ganesan is an artist, designer and educator who works primarily with the medium of light. So far, she has worked with a diverse range of institutions and companies including the ICEHOTEL, Arup, Nanayang Technological University and ION Orchard. She received her Masters in Architectural Lighting Design from the Royal Institute of Technology in Stockholm, Sweden, and Bachelors in Architecture from the National University of Singapore.



HOOKED ON LIGHT

The Natural Light project by
Little Sun and the VELUX Group

In the world's industrialised nations, we have gotten used to having light at our disposal anywhere, 24 hours a day. For the 1.1 billion people world-wide who live in off-grid regions, however, light can literally change lives – and sometimes even save them. Together with the social business, Little Sun, the VELUX Group has therefore initiated the Natural Light project. It aims to provide thousands of these people with cost-efficient, functional and beautiful solar lamps.



The challenge

Light can change lives – this simple fact becomes evident once you venture into one of the off-grid regions of our planet. Reading, learning and doing business after dark is difficult in these areas, children can study less for school, shops close down early. Security at night is compromised, providing medical services becomes much more difficult, and social life suffers. In most cases, people in these areas help themselves with kerosene

lamps – an expensive solution that is neither good for their health nor for the climate. On average, households in off-grid regions spend between 10 and 25% of their income on the fuel. In terms of emissions, sitting next to a kerosene lamp for one evening is equivalent to smoking two packets of cigarettes. And worldwide, the burning of kerosene is responsible for around 190 million tons of CO₂ emissions.

"The solution lies in the principle of shared value, which involves creating economic value in a way that also creates value for society by addressing its needs and challenges. Businesses must reconnect company success with social progress. Shared value is not social responsibility, philanthropy, or even sustainability, but a new way to achieve economic success. It is not on the margin of what companies do but at the centre. We believe that it can give rise to the next major transformation of business thinking."

Michael E. Porter and Mark R. Kramer: Creating Shared Value. Harvard Business Review, January 2011

The idea

With Natural Light, the VELUX Group and Little Sun have joined forces to change this situation. In the course of the project, 29,000 highly efficient solar-powered LED lamps will be produced. Half of them will be distributed by the NGO, Plan International, at locally affordable prices to people in Zimbabwe, Zambia and Senegal.

Frederik Ottesen, engineer and co-founder of Little Sun, says: "By replacing kerosene lanterns with solar-powered lamps, a family living off-grid can reduce their lighting energy costs by 90% over two years – and receive 10 times stronger and better quality light."

"The competition gives students the possibility both to do something real and something that is going to be helpful to people in different ways. This is a nice challenge for contemporary design, and I am happy to be a part of it."

Patricia Urquiola, jury member

"The young and upcoming designers in the competition showed a remarkable creativity and willingness to 'think out of the box'. There was a great diversity in the submissions, and also a sense of humour in many of them. This made choosing the winner both an interesting and difficult task for us."

Koyo Kouoh, jury member

"Providing access to light is not only about answering a functional need. It is also about understanding the intimate link between energy and our aspirations, our common global desire for happiness. I strongly believe that these two aspects of design must always be seen as one. The winning design addresses both – and more: it understands that holding energy in your hand makes you feel empowered. This design is empowering."

Olafur Eliasson, chairman of the jury

But Natural Light is not just about bringing sustainable light to Africa. The solar lamps have to be long-life, lightweight and suitable for a variety of purposes. Furthermore, they have to appeal to their owners emotionally as well. The three partners have therefore initiated an international competition for design students, to which 172 designs from 65 countries were entered. In May 2015, an interdisciplinary jury selected the winners: Natural Light will be produced to a design by Mariana Arando and Luca Fondello from Buenos Aires.

The jury

The international competition jury consisted of seven artists, designers, engineers and marketing experts, many of whom are among the world leaders in their respective fields:

Olafur Eliasson

(head of the jury)
Artist and co-founder of Little Sun, Berlin, Germany/Copenhagen, Denmark

Patricia Urquiola

Architect and interior designer, founder of Studio Urquiola, Milan, Italy

Ije Nwokorie

Global CEO of the Wolff Olins brand consultancy, London, UK

Koyo Kouoh

Curator, author and founding artistic director of RAW Material Company, Dakar, Senegal

Melody Sarudzayi Joachim

Nurse and vice chairperson of Alight Zimbabwe Trust, Little Sun's distribution partners, Harare, Zimbabwe

Frederik Ottesen

Engineer, entrepreneur and co-founder of Little Sun, Copenhagen, Denmark

Michael K. Rasmussen

Chief Marketing Officer of the VELUX Group, Hørsholm, Denmark

The winners

Mariana Arando (aged 22) and **Luca Fondello** (aged 23) both live in Buenos Aires, Argentina, and are studying Industrial Design together at the University of Buenos Aires (FADU). They said: "Winning such a competition could represent a huge opportunity for our future careers. We are so anxious to see our design and concept for the solar

lamp when it has been produced and is serving its purpose. We liked the idea of helping and empowering people who do not have electricity, and that was our primary motivating factor throughout the whole process."

"There was a very strong sense of diversity, very different ideas. It seemed that the appeal of the competition reached a younger group, and this makes me optimistic that solar energy will resonate with the next generation."

Olafur Eliasson, chairman of the jury

The winning model

'Light as a unifying element' was the motto that guided Mariana Arando and Luca Fondello in the design of their lamp. Rather than a stand-alone object, 'enganchate' (which, in English, means 'cling onto it', but also 'get hooked'), is a multi-purpose lighting tool that can be used as a floor, table or pendant lamp, but also be linked to form 'chains' of several elements. The body of the lamp contains three batteries, which are charged during daytime by a high-efficiency photovoltaic cell on the

back of the body. Light is produced by a latest-generation LED provided with a polycarbonate diffuser to eliminate glare.

Alongside its self-explanatory form and functional added value, 'enganchate' also responds to some specific requirements that were laid down in the competition rules. The design had to be converted into a product, with worldwide market potential, that should cost no more than 4 Euros to produce and weigh no more than 300 grams.

"At the heart of the winning lamp is a simple, poetic idea that fulfils all the competition's criteria. In design, functionality and name, it tells a captivating story, beautifully presented, about light's ability to connect a community or family and create social spaces."

From the jury verdict about 'enganchate'

The business model

The Natural Light design competition was a one-time event but has the potential to create lasting impact. The lamps will be manufactured in China and will then be distributed by Little Sun and Plan International to Senegal, Zimbabwe and Zambia. Local entrepreneurs in the three countries will receive an initial stock of solar lamps to sell at locally affordable prices in communities without electricity. They can use the profit thus generated to purchase additional solar lamps,

which, in turn, creates employment opportunities. This business model, which treats the lamps as a commodity rather than a gift, makes Natural Light a financially self-sustaining project. Project partner Little Sun can use the revenue from the sales of the first 14,500 lamps to produce additional Natural Lights. Co-founder Frederik Ottesen thus hopes that the initial supply will soon be followed by another 100,000 lamps.

"The solar-powered lamps will benefit entire communities where electricity is a scarce resource. In countries that have an unemployment rate of more than 60 per cent, this program makes a big difference to the lives of the people involved, who are given a chance to support themselves."
Gwen Wisti, Managing Director, Plan International Denmark

The partners

Alongside the VELUX Group, the following two partners are involved in the Natural Light project:

Little Sun is a social business and global project founded by artist Olafur Eliasson and engineer Frederik Ottesen to get clean and affordable light to people living in areas without electricity. The project was officially launched in July 2012 at London's Tate Modern. Since then, over 300,000 units of the project's first product, the Little Sun solar lamp, have been sold all over the world.

Plan International is one of the oldest and largest children's development organisations in the world. Founded 78 years ago, Plan operates in 52 developing countries across Africa, Asia and the Americas. So far, the organisation has initiated projects in eight sectors: education, health, water and sanitation, protection against violence, economic security, emergency relief, child participation, and sexual health.

The impact

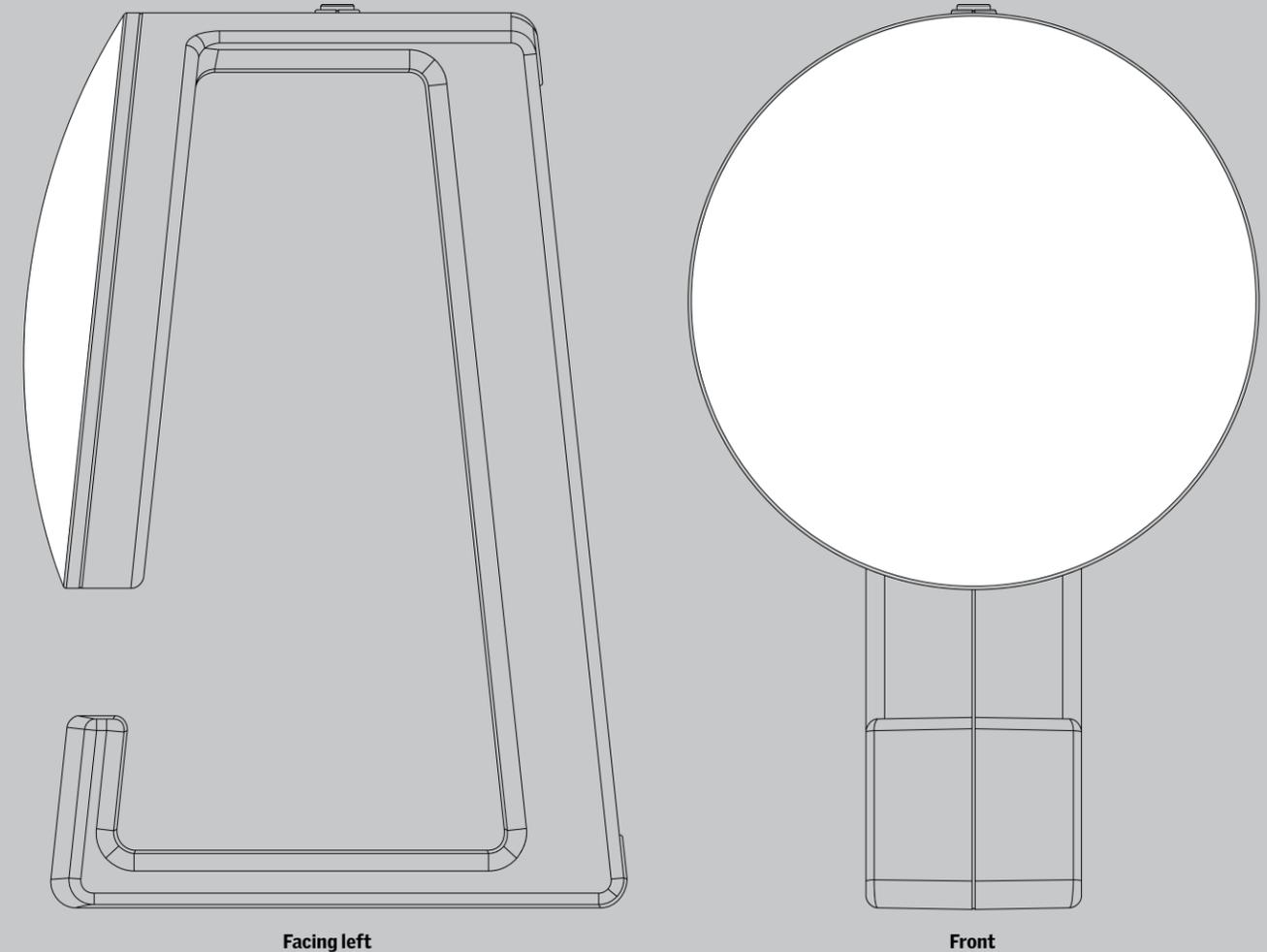
It is difficult to estimate what will happen to the Natural Lights once they are sold. But the success story so far of the Little Sun lamp provides some hints on the benefits they will provide:

Ellen Khumbulani, a distributor of the lamp from Epworth Village near Harare (Zimbabwe), reports: "My life has changed so fast. We sold all our cattle to meet medical expenses when my father died four years ago, and I never dreamt of owning livestock again. But because of this project, I foresee our family buying the lost livestock back if this project continues upward like this. I no longer have problems sending my two children to school, and I have joined with three other sellers so that we may expand our business."

Panchamp Singh, a farmer who lives on the foothills of the Himalaya in Northern India, commented: "The lamp is a relief. Now I don't have to go down the mountain to buy batteries for my flashlight. It's a tough trip for me, and it is very expensive to buy batteries. I will use the lamp to move around in the village in the evening. My eyesight is bad, so the lamp will make it much safe for me to move around."

Pascasie Redie, a basketmaker from Burundi, also hopes she will be able to afford one of the lamps soon: "If only we had this Little Sun, we could make maybe two baskets a week, and not just one as we do now. It will double our income. And the money we earn we can use to pay for school for our children, and maybe we also can go buying things we need at home."

Enganchate



"The light is clean, bright and healthy for the children, who used to develop eye and chest problems as a result of soot they had to endure from the kerosene lamps. I can confirm that should this product reach all the corners of our community, children's performances will be boosted."
Natsai Mlambo, school teacher in Chipinge (Zimbabwe)

DAYLIGHT & ARCHITECTURE
MAGAZINE BY VELUX GROUP
AUTUMN 2015 ISSUE 24

Publisher: VELUX Group, Michael K. Rasmussen
VELUX Editorial team: Per Arnold Andersen,
Christine Bjørnager, Lone Feifer

Editorial & creative advisor: Torben Thyregod
Editor: Jakob Schoof/DETAIL
Photo editor: Torben Eskerod
Art direction & design: Stockholm Design Lab @
Per Carlsson, Björn Kusoffsky, Christopher West

Translation: Sean McLaughlin
Proof-reading: Tony Wedgwood

Front, back and inside cover photography by
Ole Christiansen.

Print run: ??,000
ISSN 1901-0982

The views expressed in articles appearing in
Daylight & Architecture are those of the authors
and not necessarily shared by the publisher.

© 2015 VELUX Group.

® VELUX and VELUX logo are registered
trademarks used under licence by
the VELUX Group.

E-mail: da@velux.com
da.velux.com

Ipad version available in App store

Ole Christiansen (born 1955) is a Danish photographer who lives and works in Copenhagen. His areas of particular interest are music and portrait photography, but also photographs of urban landscapes that are characterised by vivid black-and-white contrasts and a strong graphic emphasis. So far, his work has mainly been exhibited in Denmark and the USA, at such locales as the Royal Danish Library in Copenhagen, Brandts Klædefabrik in Odense and the Scandinavia House in New York.

Thekla Ehling (born 1968) is a German photographer based in Cologne. She studied photography in Dortmund, Germany, and Limerick, Ireland, and has worked for numerous magazines in Germany and abroad, including Der Spiegel, Die Zeit, GEO, de Volkskrant, Brand Eins and NEON. In one of her previous assignments for the VELUX Group, she documented the works of SANAA, Will Bruder Architects, Jarmund/Vignsnaes, and Lacaton & Vassal in Daylight/Architecture 15.





VELUX®