OPTIMIZE **DAYLIGHTING** OPPORTUNITIES

GLUMAC DESIGN STRATEGIES

NATURAL
LIGHTING FOR ENERGY EFFICIENCY

DAYLIGHTING

Using indirect natural light to illuminate indoor spaces as an alternative to electric lighting – while maintaining uniform levels, controlling glare and reflections to create visual comfort and reduce energy costs

Daylight: bright, plentiful and, when controlled properly, creates a more vibrant and comfortable indoor experience. But while natural daylighting's benefits to occupants are most apparent, it also presents significant opportunities for energy savings and productivity improvements. Glumac designers concentrate on visual comfort, striving to achieve high-quality daylighting that actually outperforms electric lighting—and creates actively used spaces throughout the building.

It's an approach that requires a high-level of client commitment, from early stages of design (models, mockups, selection of shading devices and controls) through purchase and construction. With importance placed the building footprint (width, height, depth), key structural elements (atriums and skylights), and orientation (whether to include west-facing windows, etc.), the client and project team must evaluate potentially higher first-cost features, such as sawtooth roof design or external light shelves, that can be integrated within the lighting scheme to create an optimal building envelope. Close collaboration with the architectural team becomes essential as well. This coactivity leads to better-informed

decisions about the depth of bays, interior finishes, window orientation, and window treatments – and further ensures that glazing and skylight areas provide adequate daylight without creating glare.

MORE THAN POKING HOLES IN THE ENVELOPE

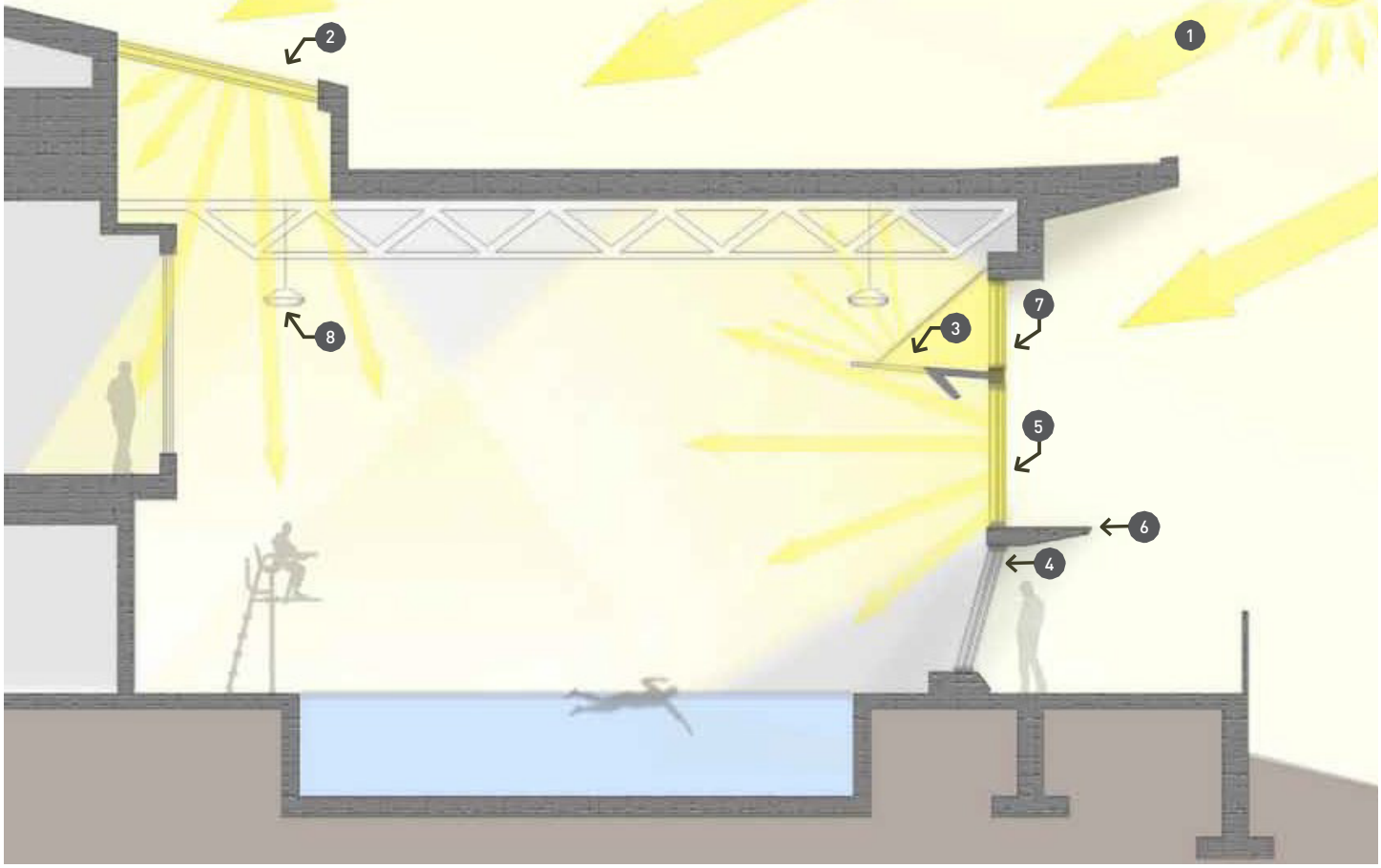
At Glumac, we believe most spaces constructed today feature more glass than necessary. Daylighting must incorporate shading strategies to accommodate the optimized views and architecture of contemporary construction. Consequently, daylighting design should control solar incidence, so reductions in electric lighting loads counterbalance any increases in heating and cooling energy from windows in the building.

Even before determining the building footprint or envelope concepts, effective daylighting begins with orientation. In many cases, an optimal floor plan runs east to west. With this orientation, the northern façade (in the Northern Hemisphere) receives even light throughout the day and the seasons. Spaces adjacent to the southern façade function well for detail-oriented activities and fabrication processes requiring visual acuity. Eastern and western façades remain the hardest to control, as the sun rises and sets at a very low angle. Because of this, Glumac's designers always give special attention to glare control. If tinted or reflective glazing becomes necessary as a last resort to remedy glare issues, Glumac recommends the use of spectrally-neutral glass, which does not "discolor" outward views. Additionally, lighter interior finishes, rather than dark colors or wood, aid in managing brightness. For example, bouncing daylight off matte-white ceilings helps to maximize energy savings while creating more comfortable working conditions for

WASHINGTON STATE UNIVERSITY RECREATION CENTER

1. direct sun light
2. translucent light diffusing skylight
3. internal light shelf/translucent light diffuser
4. clear angled glass to reduce glare
5. translucent light diffusing glass
6. exterior shading device
7. clear glass
8. fluorescent lights with dimmer ballast linked to photo sensor

Glumac's Design Goal: to provide as much daylighting as possible while avoiding direct sunlight that can cause glare, harsh or veiling reflections, and high contrast within the space – essential in aquatic settings for both comfort and life safety issues. Elements include skylights, translucent light-diffusing glass, light diffusing light shelves, angled glass and exterior shading devices.



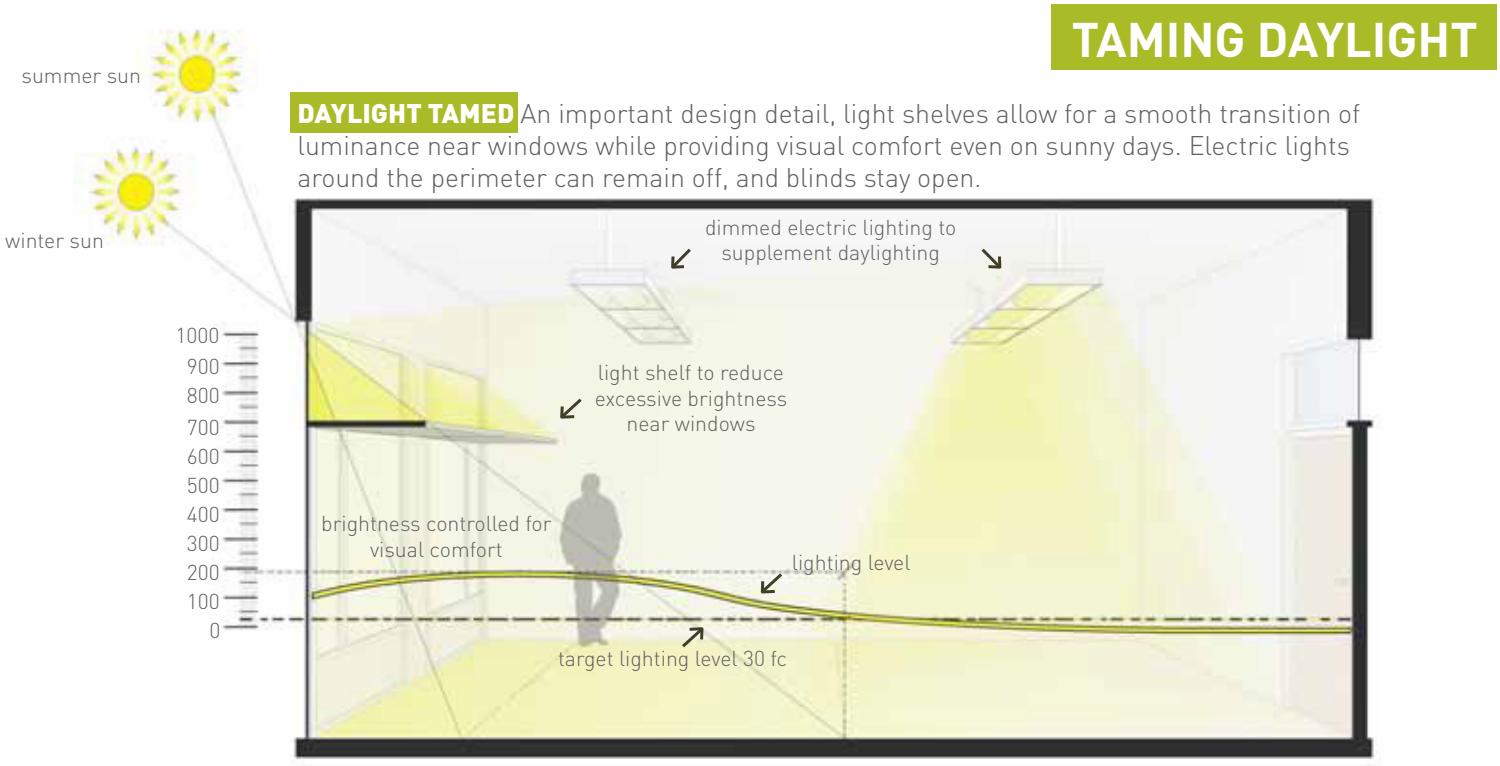
occupants.

Daylighting may be incorporated into virtually any structure. As transitional space, an atrium, for example, affords a direct view of the sky while admitting beams of sunlight, shadow patterns and variable light levels throughout the day. Warehouses function well with little or no directional lighting and allow daylighting via translucent acrylic panels and similar roof materials. Offices and classrooms present more challenging applications, as users occupy them for long periods of time and require even greater visual comfort, but proper daylighting can create optimum conditions for occupants to concentrate on tasks such as reading, writing or working at computers.

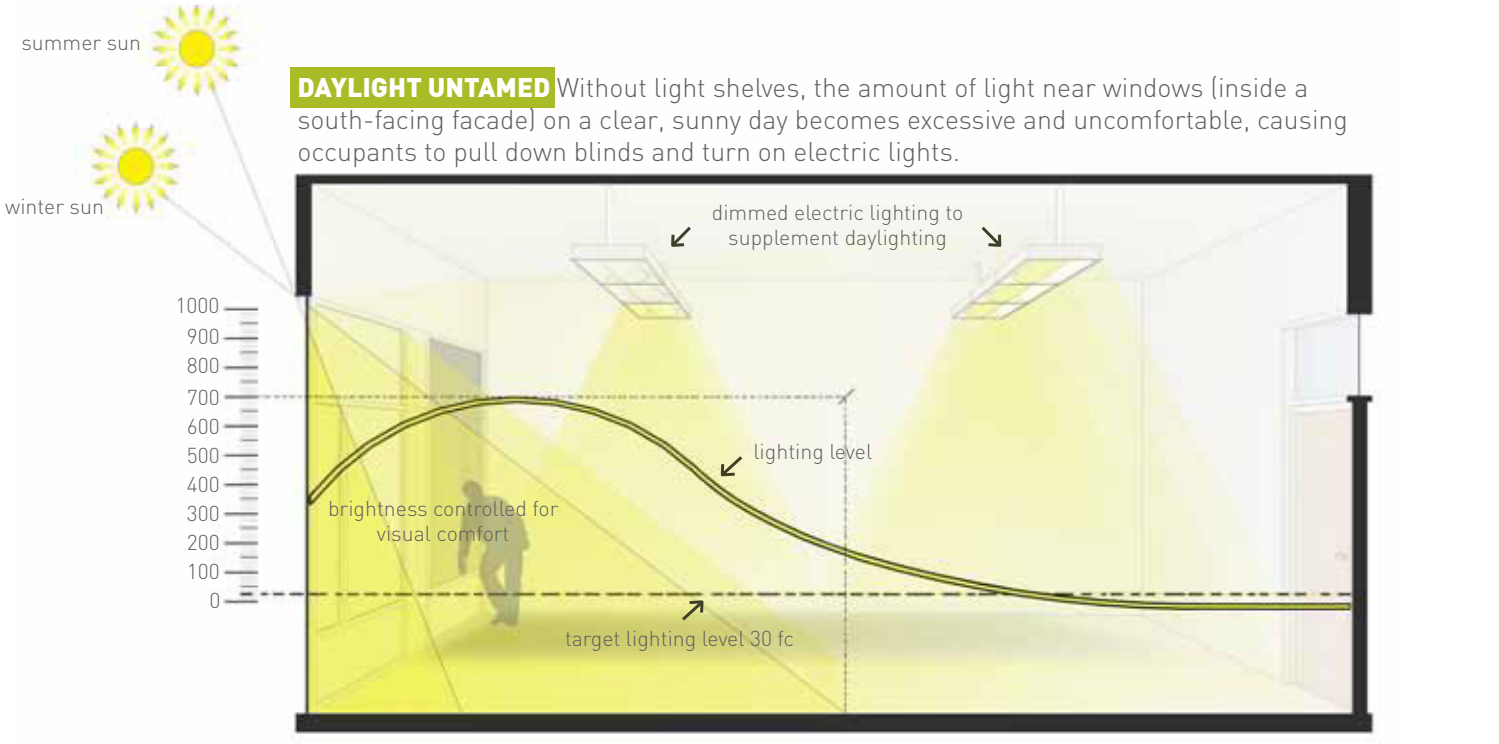
MAKING SMART USE OF LIGHT

The success of daylighting schemes also relies on creative use of overhangs, light shelves, manual

TAMING DAYLIGHT



DAYLIGHT TAMED An important design detail, light shelves allow for a smooth transition of luminance near windows while providing visual comfort even on sunny days. Electric lights around the perimeter can remain off, and blinds stay open.



DAYLIGHT UNTAMED Without light shelves, the amount of light near windows (inside a south-facing facade) on a clear, sunny day becomes excessive and uncomfortable, causing occupants to pull down blinds and turn on electric lights.

Western Oregon University's Health and Wellness Center design integrates daylighting and a highly effective building envelope, with a combination of displacement ventilation and natural ventilation, to yield 20 percent better energy performance than code.

or automated louvers, and even strategically-placed vegetation to control light and reduce solar loads – particularly on southern façades. Ideally, neither space should allow direct penetration of the sun. Many Glumac projects include interior light shelves and exterior sun shades. External building elements provide space for photovoltaic canopies; however, they may also require added maintenance due to snow and roosting birds, and pose an obstacle for window cleaners. Internal light shelves help to minimize glare in spaces adjacent to windows, yet they can lead to problems with air flow at the perimeter and inadequate heating or cooling scenarios. To help determine best-case scenarios, Glumac develops Computational Fluid Dynamic (CFD) models to understand air flows and further accommodate these elements.

Designers also recommend operable louvers or shades for clear glazed areas below each light shelf – at times even above the light shelf – to darken the room if needed. A clear indication of failed daylighting, they caution, occurs when tenants use cardboard or other quick fixes to block the glare from windows, which eliminates daylight harvesting capabilities.

> "DESIGNERS RECOMMEND **OPERABLE LOUVERS** OR SHADES FOR CLEAR GLAZED AREAS BELOW EACH LIGHT SHELF – AT TIMES EVEN ABOVE THE LIGHT SHELF – TO DARKEN A ROOM IF NEEDED."

PROCESS/TOOLS

Fundamentally, Glumac seeks to understand how light will perform through a series of daylighting studies: modeling its movement and intensity within a space while considering climate zones, time of day, cloud cover, season and other variables. Various software packages help Glumac designers create of 3D-models which, compared to earlier physical models of cardboard or wood, may be edited quickly as the building design evolves.

Engineers also focus on several key design points to optimize visual comfort for all spaces:

- Keeping building dimensions shallow enough to ensure effective penetration of daylight – particularly when not incorporating skylights
- Understanding that top-lighting can be more effective than sidelighting
- Designing electric lighting for night conditions
- Understanding a well-designed building can make electric lighting loads redundant 75 percent of the

DAYLIGHT + DESIGN

The new academic and study spaces at **Pacific Northwest College of Art** uses extensive daylighting to minimize solar heat gain and increase user comfort. Spaces that harvest daylight are important for occupant wellness, but also provide great gains in focus and productivity as well.

time, windows, skylights and control systems

- Sidelighting a building does not require floor-to-ceiling glass; in fact, fenestration only above waist height and a 50 percent window-to-wall ratio can provide sufficient daylighting for most spaces
- To effectively top-light the highest floor of any structure, skylights may be sited on just 5 percent of the building's roof area (as a rule of thumb); larger skylights can be effective with shading devices

FURTHER DESIGN FACTORS

Direct/indirect electric lighting systems play a proven role in daylighting design as well. These luminaires create visual comfort with fewer foot-candles and superior energy savings. Even in the presence of abundant daylight, some occupants prefer electric lights to stay on, dimmed at minimum levels, providing psychological reassurance that all in the building remains functional.

Also integral for daylight harvesting: good lighting controls, particularly daylighting sensors (photocells) located strategically throughout the building while factoring in window placement, window coverings, depth of bays and orientation. Sensor placement and calibration becomes critical, since the color of finishes and proximity to lighting fixtures may produce false readings and oscillating light levels. Finally, new technologies incorporate wireless controls, allowing owners and tenants to relocate sensors as needed after occupancy to further optimize their location.