



APPLY **NATURAL** **VENTILATION** SOLUTIONS EARLY & OFTEN

GLUMAC DESIGN STRATEGIES

A retractable roof provides ample **natural ventilation** for the retail galleria section of **CityCreek Center**, a 20-acre mixed-use development in Salt Lake City, Utah. Glumac can help determine if environmental factors align to allow for natural ventilation solutions, which can provide great passive energy savings.

PASSIVE

VENTILATION FOR INTERIOR CONDITIONING

NATURAL VENTILATION

The movement of fresh air – using the natural forces of wind, temperature differences and buoyancy – within an indoor space through openings in the wall of a building, without the use of a fan or other mechanical system.

Fresh air is one of the most underutilized, yet simplest measures for conditioning facilities, if ambient air quality and temperatures are conducive. The many advantages of natural ventilation include flexibility (open or closed windows), environmental control at the occupant level, and passive energy savings (versus forcing air through ducted systems). Common design schemes promote either wind-induced cross ventilation – which relies on orientation, narrow floor plates and large openings through natural buoyancy based on

temperature differentials from low intakes and high exhaust.

As with daylighting, Glumac's designers continually strive to introduce natural ventilation into buildings. Their mindset reflects a hybrid approach: sizing the HVAC system optimally for air conditioning demand while incorporating passive features into every design to take advantage of mild seasonal and climatic opportunities. They often compare this approach to operating a sailboat in the wind: determining whether to turn on the motor

or just trim the sails. Gaining owner buy-in becomes critical to success with natural ventilation, as well as addressing several potential roadblocks to this strategy. These considerations include:

- **Climate:** do high summer and/or low winter temperatures make this a practical solution?
- **Loads:** Loads in server rooms, computer labs and similar spaces may be too high to ventilate naturally
- **Geometry:** Projects with narrower footprints allow effective cross-ventilation; those with an atrium and other architectural “chimneys” maximize the potential for stack ventilation
- **Cost:** Operable windows generally cost more than fixed windows

BY PASSIVE MEANS FIRST

Glumac believes natural ventilation is a strategy that should be at the forefront of discussions for any

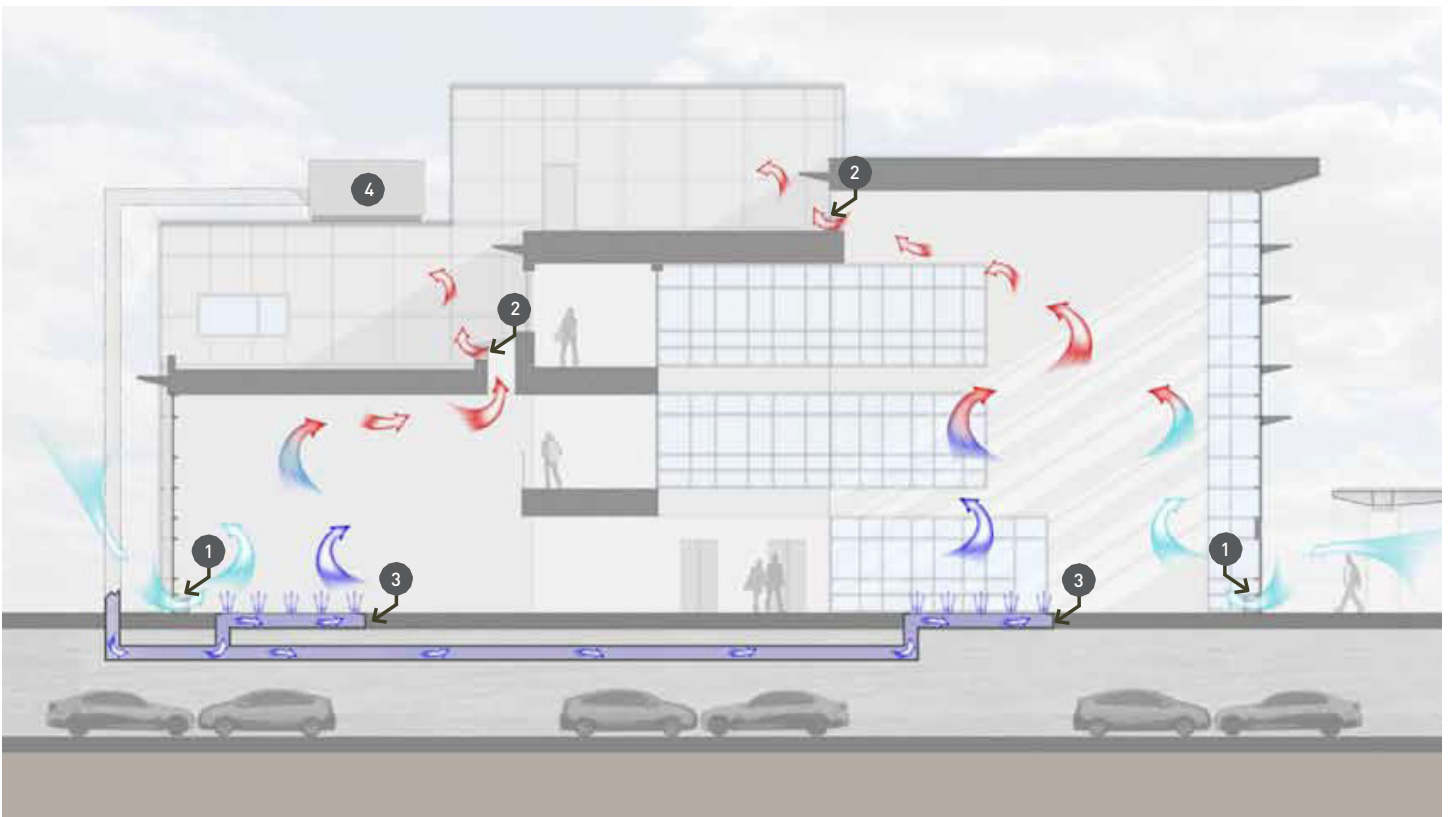
sustainable design project. Resolving concerns up front, such as outdoor air quality, noise, security or allergens, may help the owner more fully embrace this concept to create a better building. Early discussions with the architect and other members of the project team can also streamline the design process. For example, optimizing the building envelope reduces internal loads to allow passive conditioning at higher temperatures. Shaping the building for airflow means narrowing floor plates for cross ventilation and including stack elements, such as an atrium, to promote fresh air strategies such as night purging. Also, adding more simple building controls may improve the operation of some passive ventilation schemes.

Operable windows represent perhaps the most visible symbol of a naturally-ventilated building, and are ideal for perimeter spaces. By providing occupant control, manual windows work well for individual offices, conference rooms, residential towers, and hotels. Yet they can be problematic for open offices

NATURAL VENTILATION: STATE OF OREGON NORTH MALL OFFICE

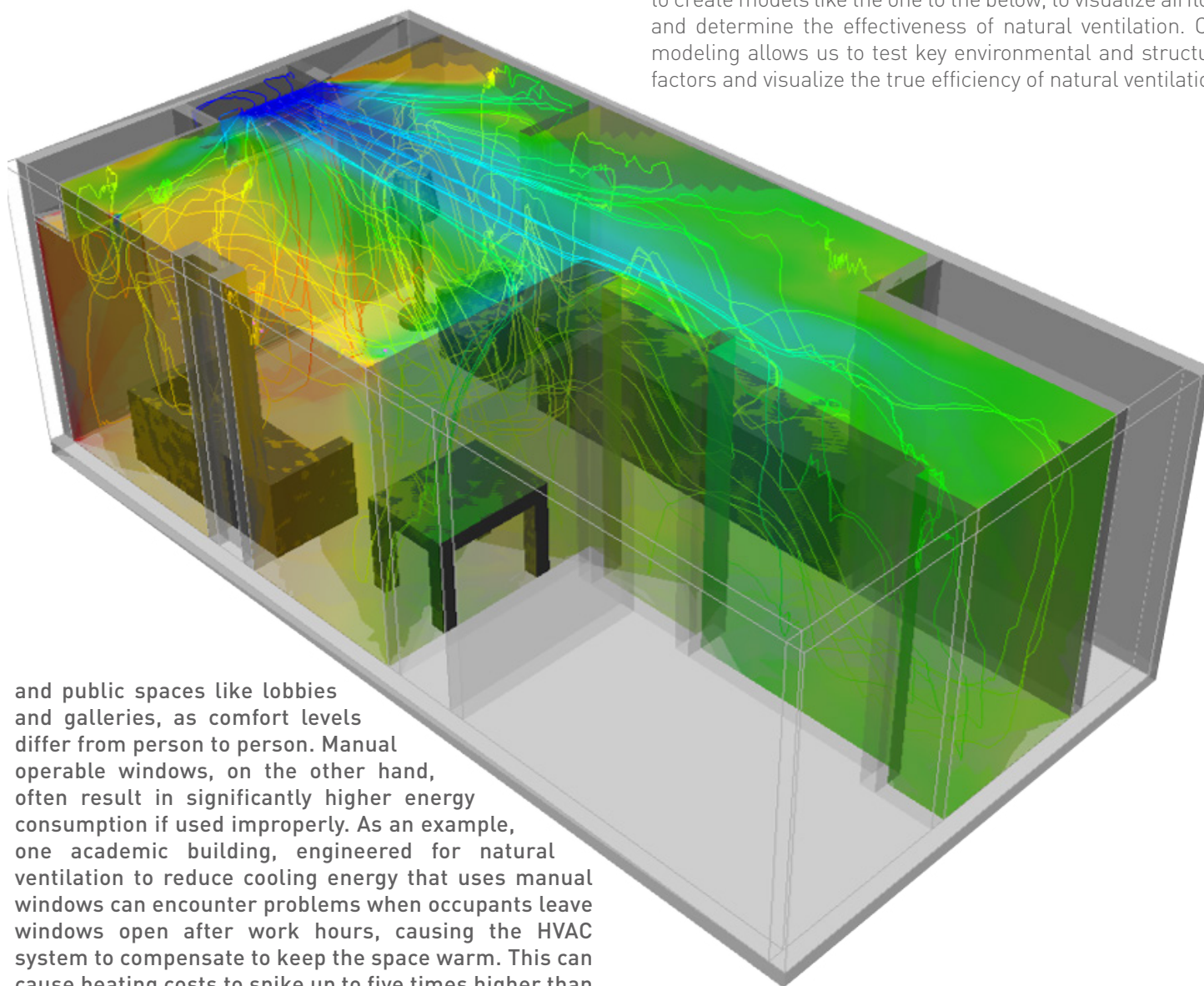
1. natural ventilation inlet integrated into perimeter bench
2. natural ventilation relief integrated into south facing skylight and clear-story windows
3. relief air from office space air-handling unit (AHU) recirculated in atrium through floor diffusers
4. office space AHU with relief air ducted to atrium

Transition Space: The North Mall atrium recirculates relief air (78°F/25.6°C) from air handlers serving office space throughout the 115,000 square foot, three-story building. Strong airflow and slightly higher temperatures within the atrium yield comfortable conditions year round. The recirculation system, combined with the natural ventilation scheme, also produces energy savings by optimizing the conditioned air and relying on the natural buoyancy of warm air rather than mechanical equipment to ventilate the space.



COMPUTATIONAL FLUID DYNAMIC MODELING

Glumac uses **Computational Fluid Dynamic** (CFD) software to create models like the one to the below, to visualize airflows and determine the effectiveness of natural ventilation. CFD modeling allows us to test key environmental and structural factors and visualize the true efficiency of natural ventilation.



and public spaces like lobbies and galleries, as comfort levels differ from person to person. Manual operable windows, on the other hand, often result in significantly higher energy consumption if used improperly. As an example, one academic building, engineered for natural ventilation to reduce cooling energy that uses manual windows can encounter problems when occupants leave windows open after work hours, causing the HVAC system to compensate to keep the space warm. This can cause heating costs to spike up to five times higher than other buildings on the same campus.

USE TECHNOLOGY WHEN APPROPRIATE

Operating guidelines and other procedures for occupants become more essential with passive designs, as do automated control systems. Several Glumac projects feature micro-switches to shut off the HVAC system automatically when windows open, or during off-hours. Use of motorized windows, louvers and dampers also facilitate overnight purging as part of a larger control scheme to freshen indoor air quality and cool a building naturally following the previous day's heat-producing activities and increased solar loads in summer. Typically, controls open windows and other

intake points automatically in the evening or early morning hours (between 2 a.m. and 4 a.m.), exhausting stagnant air through high openings. Again, early design decisions shape building loads, programming and overall architecture to make night purges as effective as possible.

PROCESS/TOOLS

Glumac engineers base their natural ventilation designs on intuition and experience, all coordinated closely with the architect. Initial designs are then tested using computer-based CFD (computational fluid

ARCHITECTURAL INTEGRATION

OF PERIMETER BENCH DETAIL



In summer, louvers inside a bench open with the heaters off, allowing a maximum amount of fresh outside air to naturally ventilate the interior space



In winter, louvers inside the bench close with the heaters on – this design warms a minimum amount of cold fresh outside air, while heating and recirculating the cold air at the perimeter windows of the space.



COMFORT + PRODUCTIVITY

Day or night, natural ventilation can provide an optimum level of thermal comfort, making interior conditions ideal for occupants to focus and be productive throughout the day. Large openings and intakes on the windward side of a building that couple with discharge spaces on the opposite side of the building allow for proper pressure differentials and create comfortable cross ventilation.


dynamics) modeling to predict air flow within spaces more precisely and help guide overall decision making.

Designers also factor in several general guidelines and pre-conditions:

- **Space ventilation:** The design must ventilate a minimum of 4 percent of floor area to meet code
- **Cross ventilation:** Limit exterior-to-exterior distance to less than or equal to five times the height of the space; for example, if the space is 10 feet (3.048 m) high, limit the exterior-to-exterior distance to 50 feet (15.24 m)
- **Pressure drop:** Limit motorized openings to very small pressure differentials of less than 0.05 inches (0.127 cm) to induce stack ventilation
- **Window openings:** design large openings and place intakes on the windward side of a building, with outtakes/reliefs on the leeward or discharge side
- **Building loads:** Calculate to keep equipment, lights, etc, at no more than 1 W/sf (10.76 W/sm)

so internal loads do not need mechanical cooling systems

FURTHER DESIGN FACTORS

Natural ventilation depends in part on occupant cooperation for its success. Passive design, by nature, requires broad tolerances – particularly with indoor air temperatures varying from 68°F to 78°F (20°C to 25.56°C) to achieve ideal comfort levels in most climates. As a result, occupants should dress appropriately for the season. Glumac also continues to experiment with behavioral tools like the Center for the Built Environment's "red light/green light" system, used to notify occupants to open or close windows. These lights can be located at the perimeter of a space or as a small dot in the corner of computer screens: red means temperatures are too hot or cold to naturally ventilate, while green indicates optimal conditions. 

FOR FURTHER INFORMATION, PLEASE CONTACT US BY EMAIL VIA contactus@glumac.com.

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