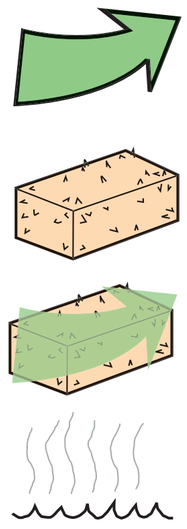
Passive Energy Harvesting Systems

LandLab at Ball State University

OVERVIEW

Before mechanical systems and other technology, people kept comfortable by using natural methods such as breezes flowing through buildings, thick walls to radiate heat in a space, or even water evaporating from fountains to raise the humidity of a space in dry climates. These passive ideas were developed over the years as integral parts of building design. In recent time, we have seen buildings become less responsive to the environment and the building site; thus, creating unnecessary use of fossil fuels and non-local resources. At Ball State University's LandLab, these passive heating and cooling methods are not used as "alternative" means, but rather they are incorporated as part of the building to minimize the role in which active systems must be used.

STRATEGIES



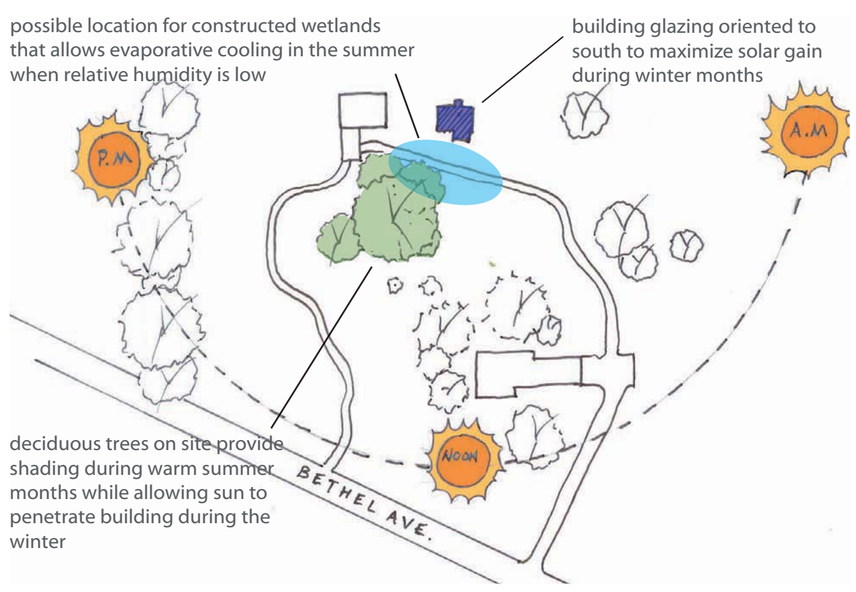
Natural ventilation depends solely on air movement to cool occupants. Window openings on opposite sides of the building enhance cross ventilation driven by breezes. Since natural breezes can vary, spaces can enhance natural ventilation by using tall areas within buildings, known as stacks. With openings near the top of the stack, warm air can escape, while cooler air enters the building from openings near the ground. Ventilation requires the building to be open during the day to allow air to flow through the stack.

High thermal mass depends on the ability of materials in the building to absorb heat during the day. Every night the mass releases heat, making it available to absorb heat again during the next day. To be effective, thermal mass must be exposed to occupied spaces. The thick straw bales and the concrete slab in the sunroom help to maintain heat during the night. While straw bales are not a great source of high thermal mass, they do serve as a good insulation source.

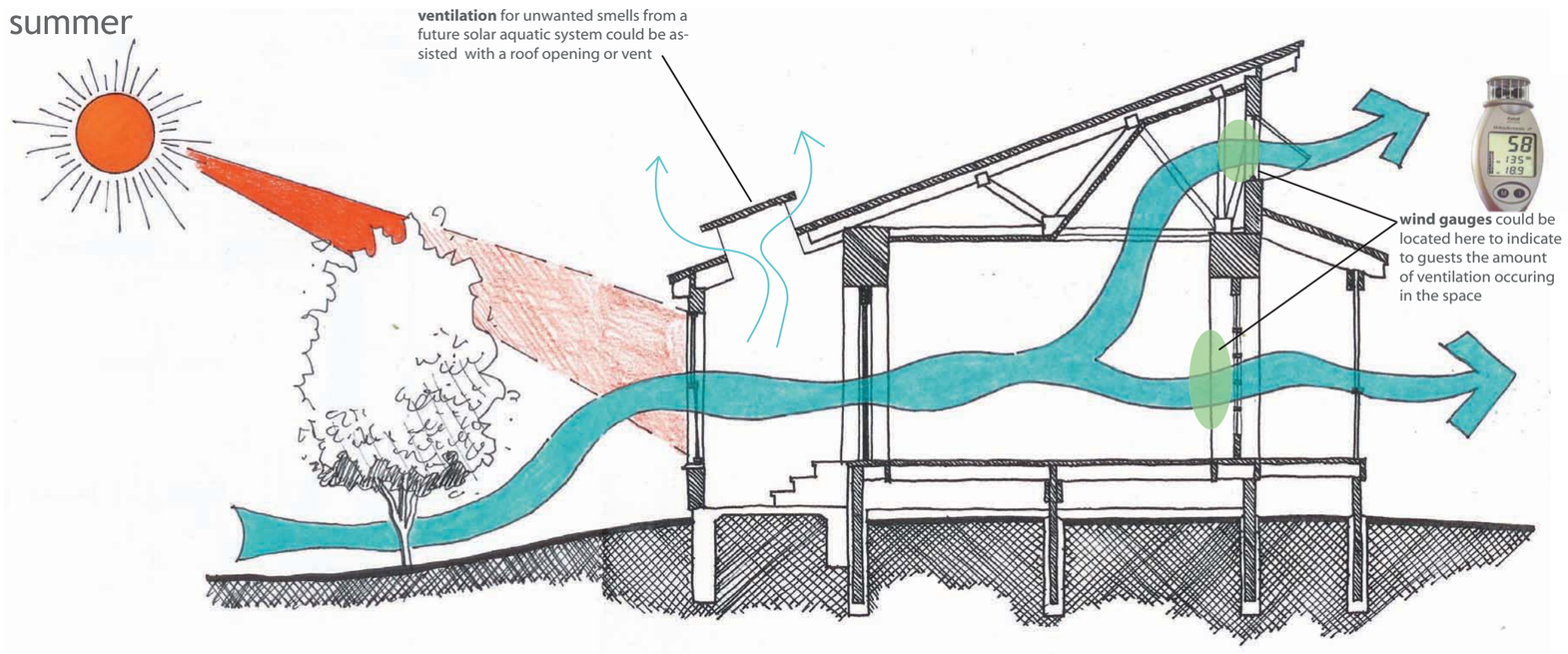
High thermal mass with **night ventilation** relies on the daily heat storage of thermal mass combined with night ventilation that cools the mass. The sunroom on the southern side of the LandLab allows for heat gain during the day. At night, this room is opened to allow heat to circulate into the occupied space. With this strategy, the building must be closed during the day and opened at night to flush the heat away.

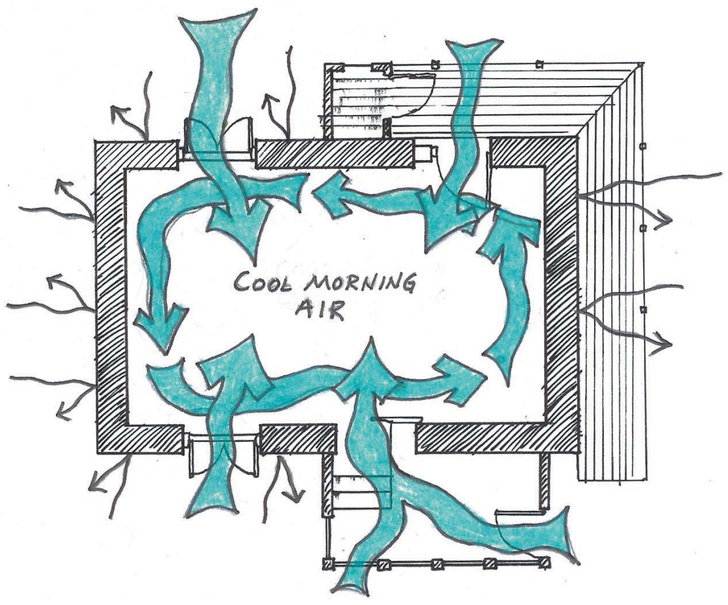
Evaporative cooling lowers the indoor air temperature by evaporating water. In dry climates, unlike Indiana, this is commonly done directly in the space. However, indirect methods, such as roof ponds or water sources located directly adjacent to the building allow evaporative cooling to be used in more temperate climates.

ORIENTATION



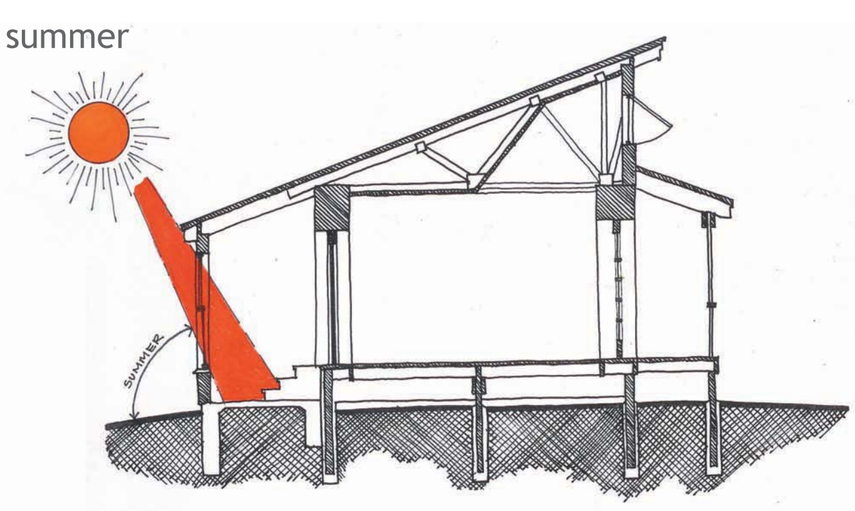
NATURAL VENTILATION

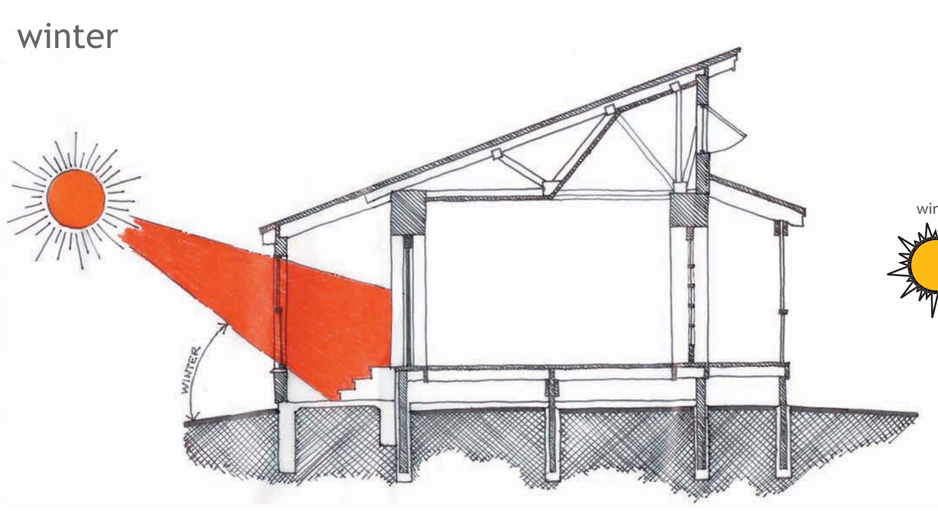


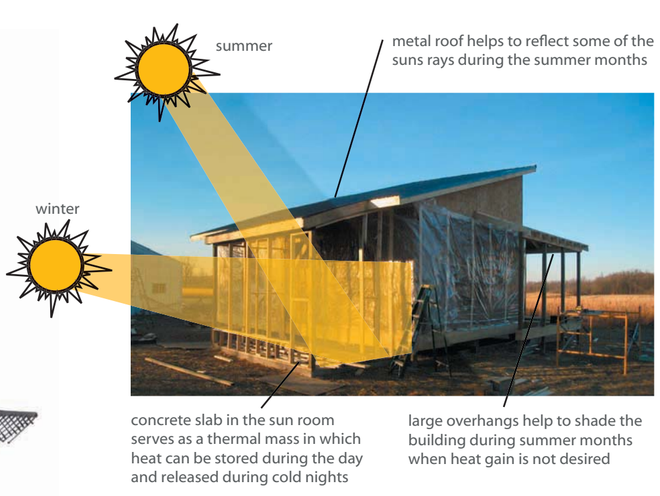


Natural ventilation on the LandLab site is promoted through the use of a "stack" within the building. The high occupant space promotes heat to rise and be flushed out of the clerestory windows. Deciduous trees outside the building also promote shading during the day, yet, still allow air flow below the trees and into the building. As well as ventilation, **thick walls** resist heat from entering the space. Since thick walls retain heat, effort must made to make sure that ventilation occurs during the day to reduce the build-up of heat inside the building.

SUN ANGLE

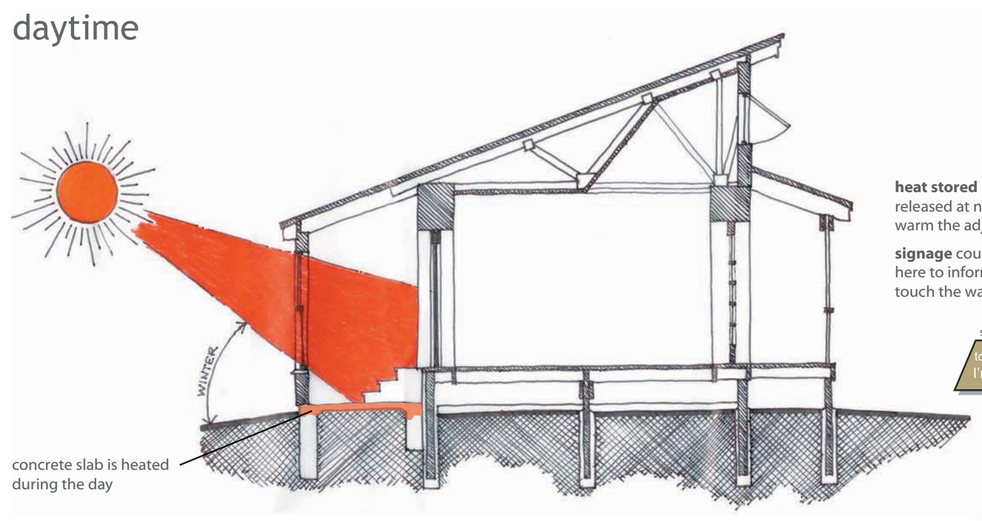


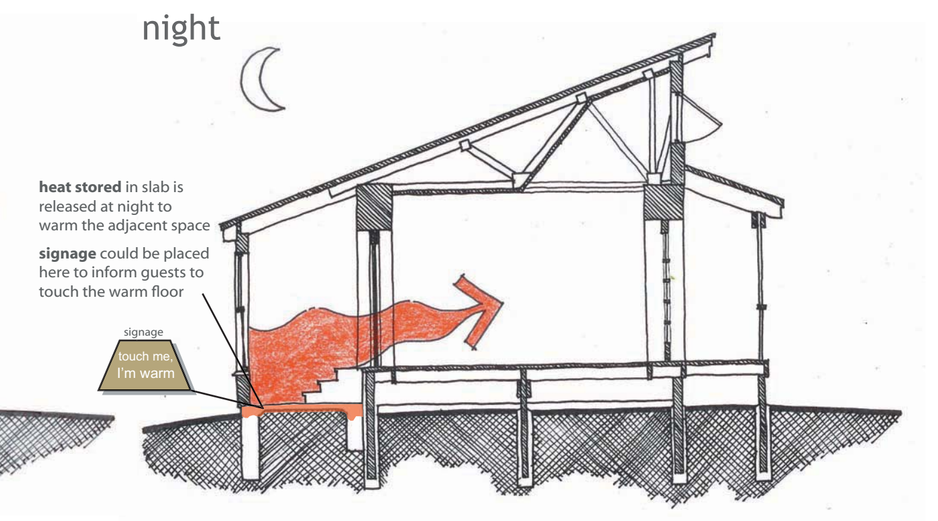


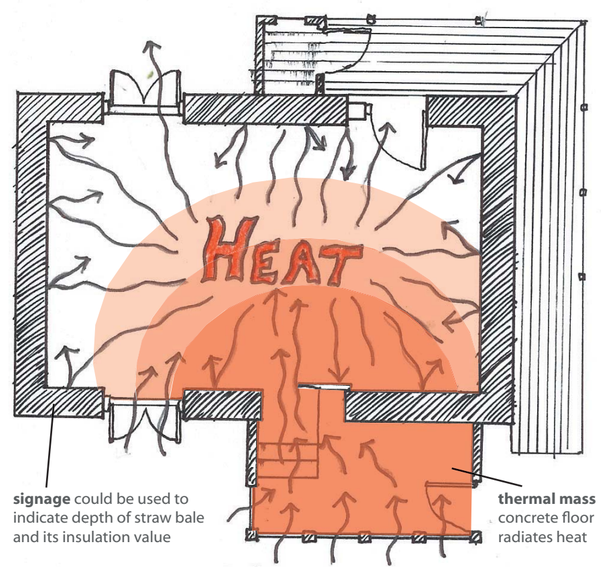


Sun angles differ throughout the year, therefore, passive solar gain can be used during the winter months due to the suns low angle in the sky. The low angle of the sun during winter months allows the suns rays to penetrate further into the space. Deciduous trees also permit the suns rays to penetrate the building, while blocking them during the summer, when heat gain is not desired. The suns high angle in the sky during summer months is also restricted by the buildings overhangs. The metal roof on the LandLab building also helps to reflect some of the suns rays in the summer.

THERMAL EFFICIENCY







Thermal efficiency of the LandLab building relies on the thickness of the walls as well as the sunroom space. The thick straw bale construction has a high insulation value that traps heat within the building during the day. This heat is maintained throughout the night. The concrete slab in the sunroom also serves as a thermal mass that can be released during the night into the main living and working space.

Mike Schulte \ Brad Fairchild