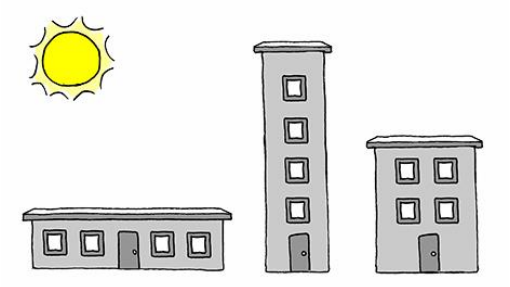
Massing and Building Orientation

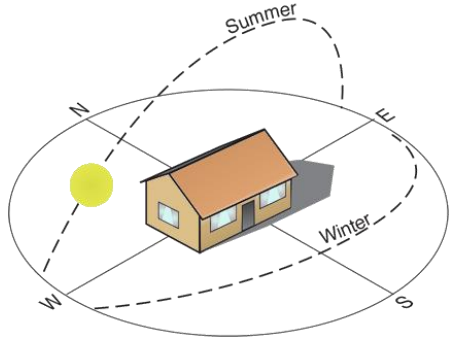
IN THE PASSIVE DESIGN PROCESS

Click To Get Started!!

Passive Design refers to a design approach that uses natural energy sources in place of purchased energy such as electricity or natural gases. Depending how a structure is designed, the natural energy from the sun can be used for heating, cooling, and natural lighting. Passive designs require very little maintenance, and can greatly reduce a buildings energy consumption. There are many different strategies used in the passive design process. My research focused on the building massing and building orientation portion of the passive design process.



BUILDING MASSING



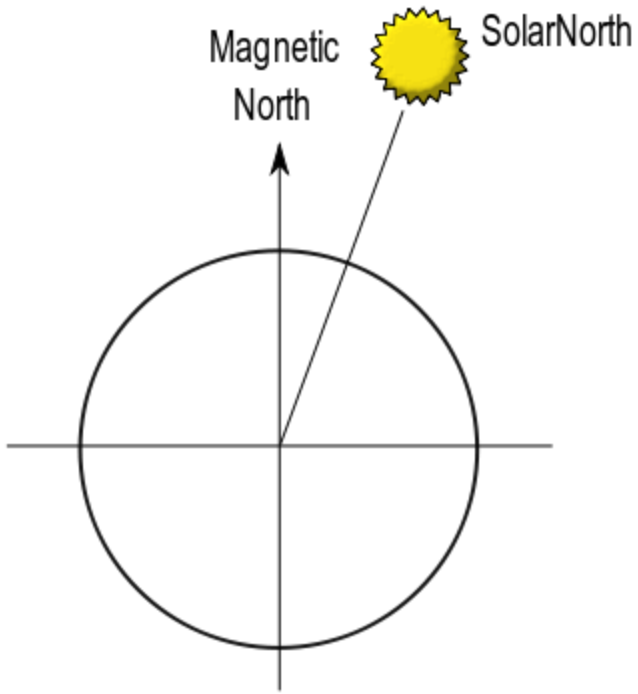
BUILDING ORIENTATION

DONE?

BUILDING ORIENTATION is the process of deciding which direction a building will face. The orientation of a building is important for street appeal, aesthetics, drainage considerations, and most importantly energy consumption. Building orientation helps developers and designers take advantage of the suns free energy, which overtime, will reduce the overall energy consumption of the building. To properly orient a building, it is important to understand the true position of the sun and how it will effect the building.

The Suns True Position:

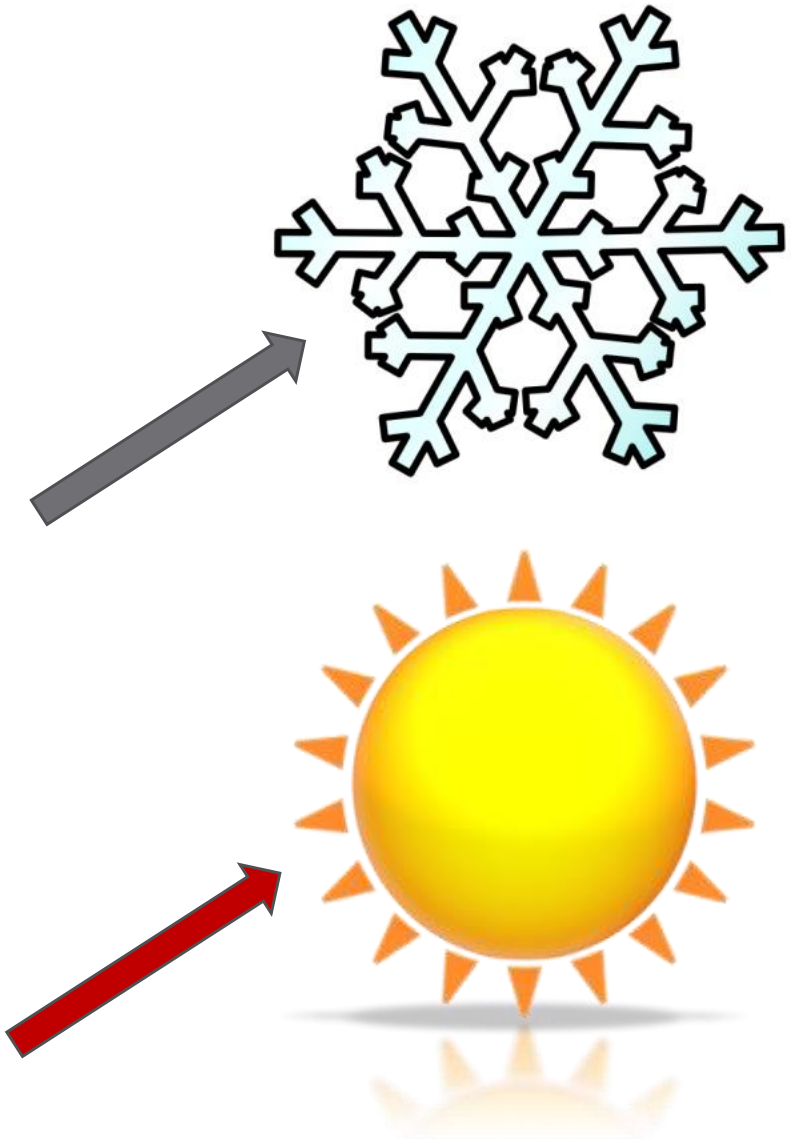
Click the image to the right to learn more about the suns true position



HOME

THE SUN'S TRUE POSITION:

"The sun rises in the east, and sets in the west." While this statement is accurate, it serves as a simplified explanation to the path of the sun. In reality, the sun only rises and sets east and west during the autumnal and vernal equinoxes. The path of the sun is completely different throughout the remaining 363 days of the year. The tilt of the earth directly effects the direction of the sun to rise and set. Click to learn how the tilt effects the path of the sun during the winter and summer months



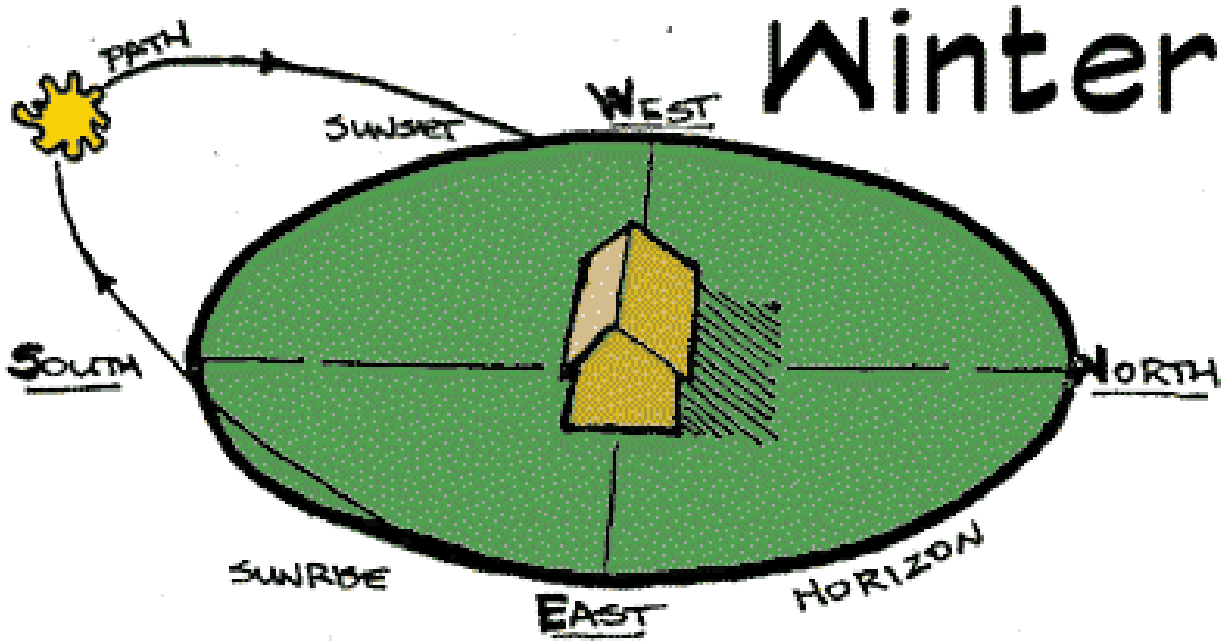
Finished? Click NEXT to learn how the suns variation can affect building design.

BACK

NEXT

SUN PATH:

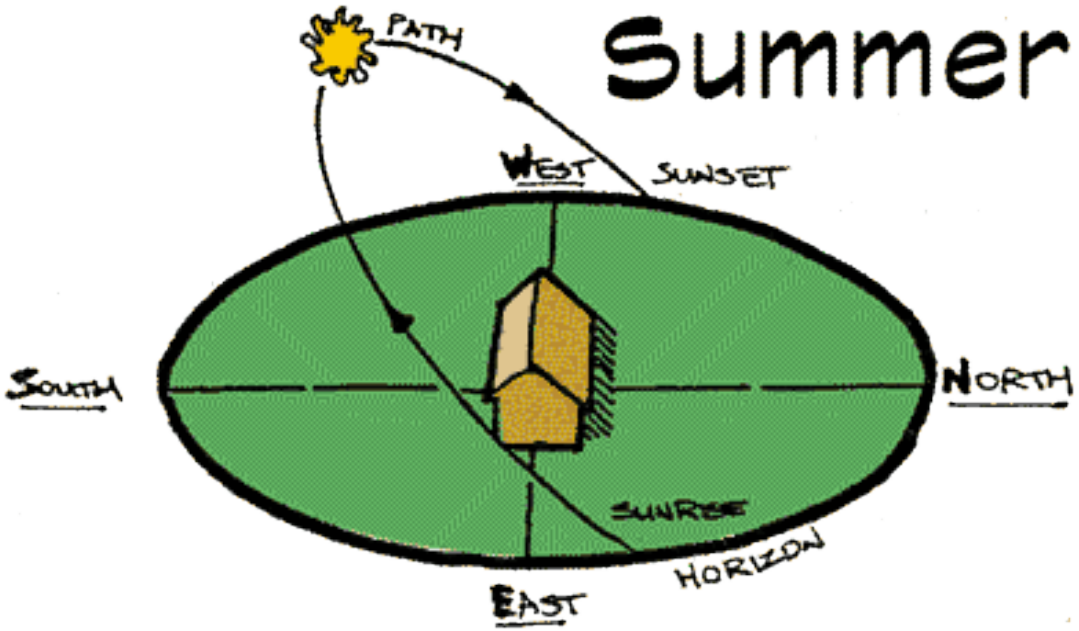
In the winter months, the tilt of the earth causes the sun to rise and set slightly south of east and west. The graphic below represents the exact path of the sun during the winter months.



As a result, the winter sun spends the majority of time in the southern sky

BACK

SUN PATH:



In the summer months, the tilt of the earth causes the sun to rise and set slightly north of east and west. The graphic to the left depicts the path of the sun during the summer months.

As a result, the summer sun spends the majority of its time in the northern sky

BACK

HOW DOES THE SUNS POSITION AFFECT BUILDING DESIGN?

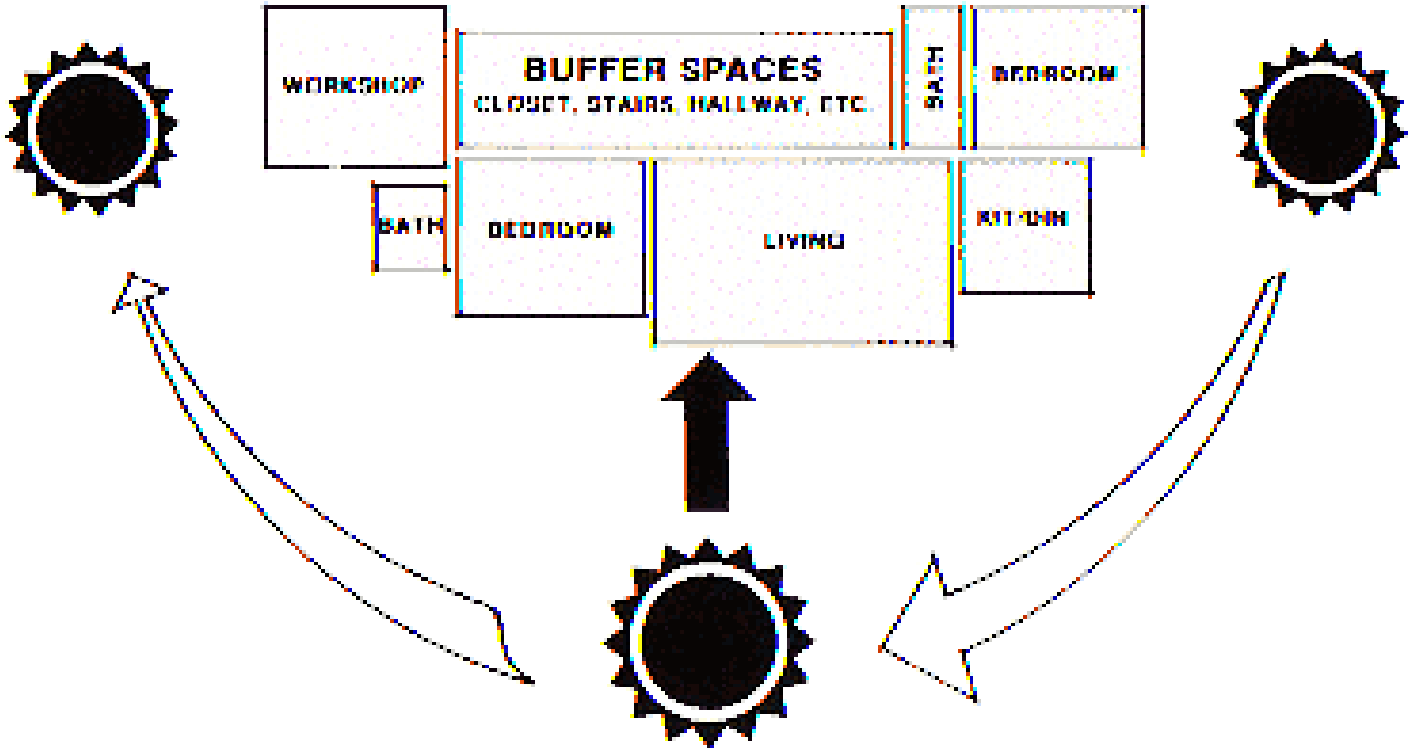
- ORIENT THE FLOOR PLAN
- BEWARE OF ELEVATION
- WINDOW PLACEMENT
- MATERIALS
- WIND VENTILATION

The position of the sun plays an important role in the amount of heat gained in a building. This makes the exact orientation of the sun a fundamental concept to understanding in passive design and construction. In my research I found several methods used to compensate for the location of the sun in the different months.

HOME

Orientation of the floor plan

it is important to not only orient a building toward the sun, but a designer should also consider directing the entire floor plan in accordance to the sunlight. Rooms that are most frequently used should be placed on the southern side of the structure. Due to the angle of the sun in the winter, occupants will enjoy the warmth of the suns rays. Subsequently, they will also enjoy the relief from the sun in the summer months. Rooms that are not frequently used should be situated more towards the northern section of the house. These rooms will act as a buffer during the cold winter winds.



BACK

HARSH ELEVATIONS

The north to south sun is exaggerated with mountainous, dramatic, or hilly elevations. In these areas significant climate differences can be see in small areas. If a building is being built on a slope, it should be constructed on the south facing slope to avoid the extreme shading created by the peak of the mountain. Building a structure halfway up a slope is ideal, for it is sheltered from the strong winds, will receive a proper amount of sunlight, and will prevent drainage issues.

BACK

WINDOW PLACEMENT

In passive design it is important to install as many windows as possible. Assuming that the structure is properly oriented with the suns alignment, proper window placement will ensure that the correct amount of sunlight is entering the building. A “sun-tempered” house should include enough be equal to about 5% of the proposed square footage of the building. For buildings with windows on only ONE side of the building, natural ventilation will not reach farther than two times the floor to ceiling height into the building. For buildings that have windows on both sides of the building, natural ventilation will be at least five times the floor to ceiling height into the building. This means that in order to achieve the most natural ventilation, a building should be constructed with windows on opposite sides from each other.

BACK

MATERIALS

The material choice for the project plays an important role in the buildings passive design. Proper materials can help avoid unwanted heat gain in warmer climates or can help store the suns heat with thermal mass in warmer climates.

BACK

WIND VENTILATION

When designing the orientation of the building, it is important to lay it out such that the buildings shorter axis align with prevailing winds. Aligning it this way will allow for the most WIND VENTILATION. This is depicted in the image below. Notice how when the building is oriented so that the larger surface faces the wind, the building is receiving more wind ventilation. Orienting the building so the most narrow wall surface is facing the wind limits the amount of wind ventilation. CROSS VENTILATION is another method used in the passive design process that uses natural wind current for building cooling.

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WIND VENTILATION

is a kind of passive ventilation that uses the natural force or movement of wind to push/pull air through a building.

WIND VENTILATION is known for being the easiest, most common, and inexpensive form of passive cooling and ventilation.

In order to get the most out of wind ventilation, the pressure difference between the inward air and outward air should be maximized. Higher pressure is known to occur on the windward side of a building and lower pressure occurs on the outward side.

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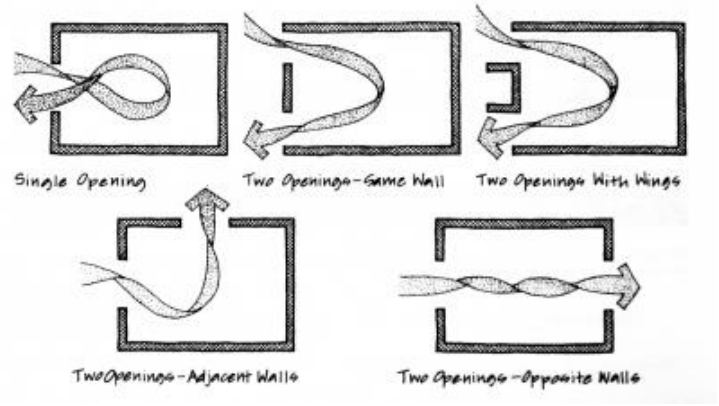
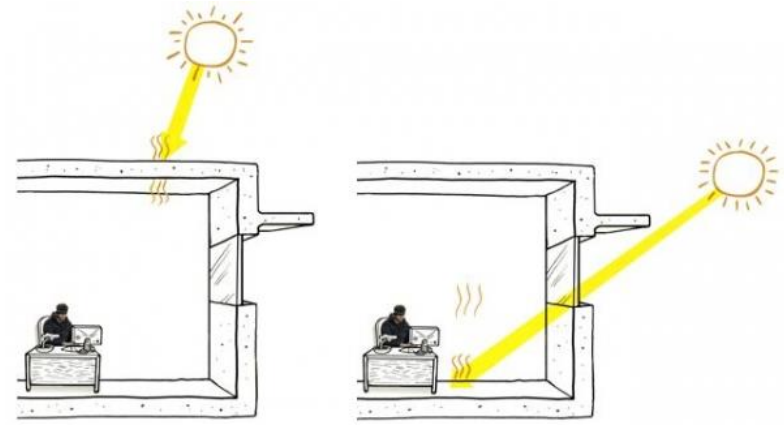
CROSS VENTILATION

is a kind of passive ventilation that helps with air flow. Multiple windows on a building work as inlets and outlets which helps pull wind in and then suck it back out. These windows act as vents and allow for natural breezes to flow through the structure. The diagram below shows the different methods of window placing in cross ventilation. Placing windows opposite from each other causes the rooms air to mix, bringing in cooling and refreshing air to the structure.

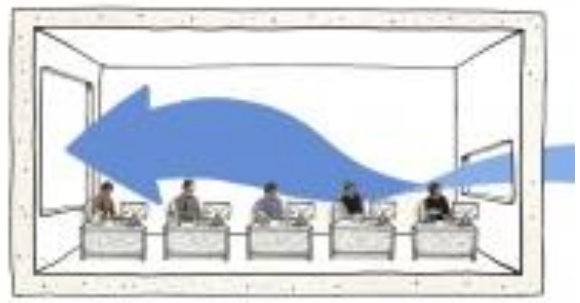


BACK

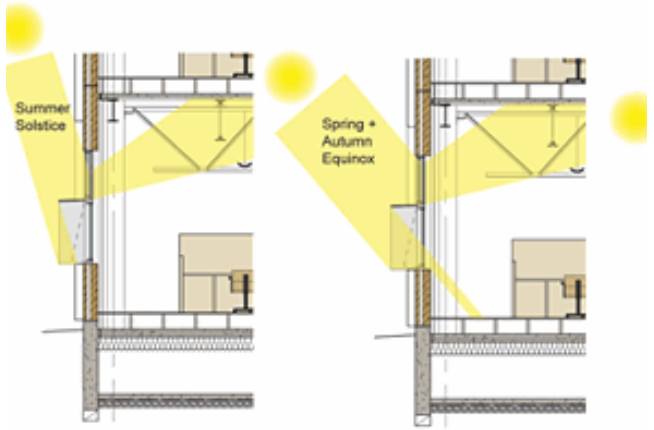
BUILDING MASSING is an important part in the design process that decides the shape and overall size of a structure. A building that is successfully massed will use the general shape and size of the building to maximize its free energy from the sun and the wind by minimizing energy loads. Passive heating, cooling, and daylighting are all important factors that are considered in massing a building during the design process.



PASSIVE HEATING



PASSIVE COOLING



DAYLIGHTING

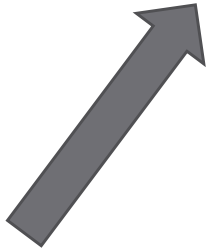
HOME

PASSIVE HEATING

uses the energy of the sun to control the interior climate of a structure without the use of a mechanical system. My research found several different massing strategies used in passive heating design. The ideal strategy is completely dependent on the climate and intended use of the proposed building.

The ideal strategy is completely dependent on the climate and intended use of the proposed building. This means that passive designs for cold climates differ from designs created for hotter climates.

WARM CLIMATES



COLD CLIMATES

BACK

PASSIVE COOLING is an important part in the passive design process that decides the shape and overall size of a structure. A building that is successfully massed will use the general shape and size of the building to maximize its free energy from the sun and the wind by minimizing energy loads. Passive heating, cooling, and daylighting are all important factors that are considered in massing a building during the design process.

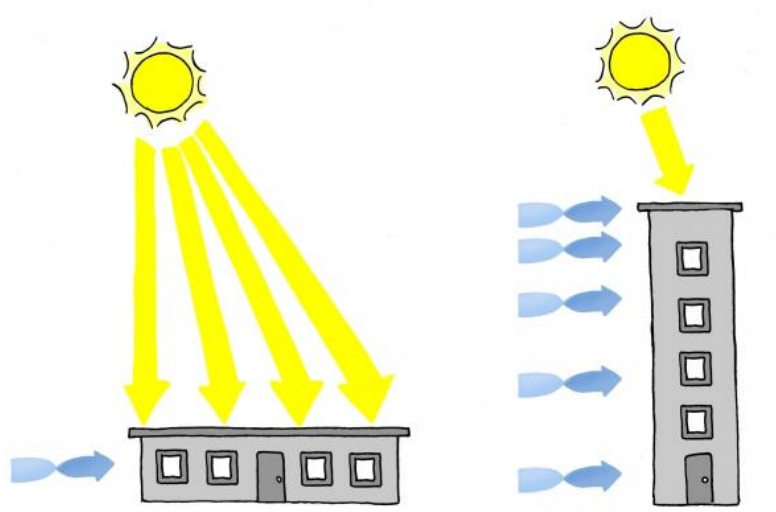
CLICK FOR PASSIVE COOLING STRATEGIES

BACK

WARM CLIMATES

In warmer climates buildings that are designed with their biggest face exposed to the sun can cause solar heat gain. In warmer environments, shading and properly placed windows can be implemented to reduce the heat gain while also allowing in natural ventilation. The heat given off by the sun strikes mostly on the rooftops of buildings. Therefore, taller buildings can reduce heat gains because typically a taller building has a roof with a smaller surface area. The smaller the rooftop surface area, the smaller the heat gain.

Unlike sunlight, the sings heart does not come from all directions Walls facing the suns path will get the most light and the most heat. Windows that face toward the east are warmed in the morning while windows facing west are heated in the afternoons.

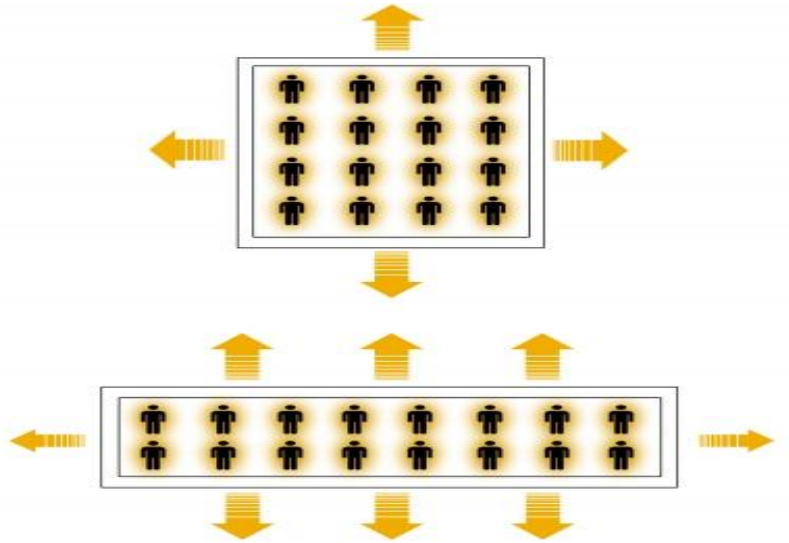


BACK

COLD CLIMATES

buildings that are proposed for colder climates should be massed so that the ratio of the surface area to volume. A building design with a smaller surface area to volume area will subsequently reduce unwanted heat loss in the building. Being able to reduce the amount of heat loss in a building helps reduce the amount of mechanical or electrical energy that the building needs to stay warm in colder climates.

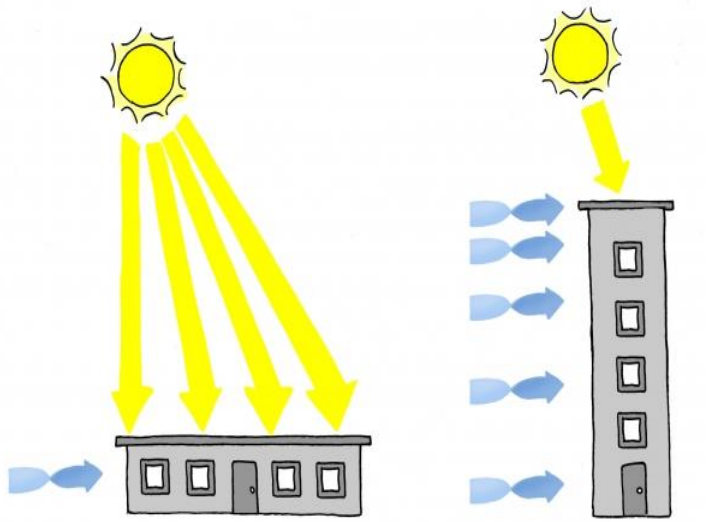
Buildings that are densely populated such as the diagram to the immediate right, generate a great deal of heat based on the amount of generated energy.



BACK

STRATEGIES FOR PASSIVE COOLING

properly massing a building plays an important role in passive cooling. Passive cooling focuses on heat dissipation in a building with the goal to improve the interior thermal comfort level while also decreasing energy consumption. This strategy works by either prevent unwanted heat from entering the building or by taking the heat from the building and removing it. Preventing unwanted heat is referred to as heat gain prevention, and removing heat already inside the building is referred to as natural cooling. Both of these strategies rely solely on the proper passive design of building components and how well the design utilizes natural resources such as wind and the suns heat. In terms of massing, two common building practices are utilized for passive cooling. Designing taller and thinner buildings can reduce unwanted heat gains while also eliminating the use of mechanical or electrical systems.



CLICK DIAGRAM TO LEARN MORE!

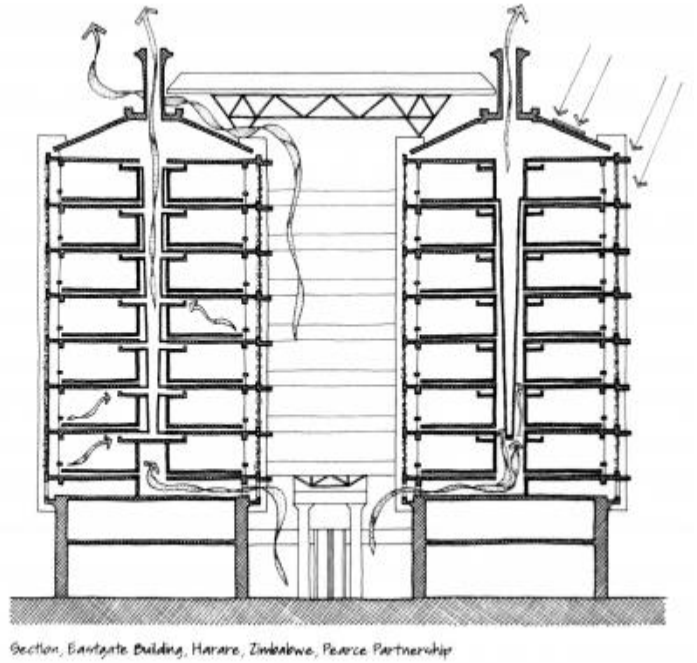
BACK

THIN BUILDINGS

Unlike passive heating, passive cooling requires the design to **increase** the surface area to volume ratio of the building. Increasing this ratio will make utilizing natural ventilation easier to incorporate. Natural ventilation is the process of supplying and removing air from an interior structure without the use of a mechanical or electrical system. This technique only works if the building is both massed and oriented correctly. If a building is oriented in a way that blocks natural wind, then natural ventilation will not work in the design.

TALL BUILDINGS

similar to thinner buildings, taller buildings also will increase the effectiveness of natural ventilation. At higher altitudes wind speeds are the greatest. The increased wind speeds make natural ventilation more effective. Taller buildings also improve the stack effect ventilation. Stack ventilation uses temperature differences to move air throughout a structure. In low pressure environments hot air will rise. Ideally the height of the building will pull air from the bottom of the structure up and then out, eliminating unwanted heat stuck in the building.



Section, Eastgate Building, Harare, Zimbabwe, Pearce Partnership

BACK

DAYLIGHTING is the use of daylight in a building used to control the visual comfort as well as thermal comfort. Proper daylighting techniques will help use the light from the sun to decrease the use of an electrical or mechanical system by taking advantage of natural lighting. The massing strategies used in daylighting are similar to the techniques used in passive heating. Larger buildings can increase natural light exposure through the use of various skylights. Skylights allow single story buildings, no matter the size, to achieve daylighting through out the day. Buildings that are taller then one floor should be designed with thinner profiles. Because the sun will hit the sides of taller buildings, windows should be taller and wider to allow in natural lightning. Buildings can have different shapes or cutouts. Atriums and courtyards allow for more light to reach the interior areas of the building. Also buildings that are longer East-West are better for daylighting

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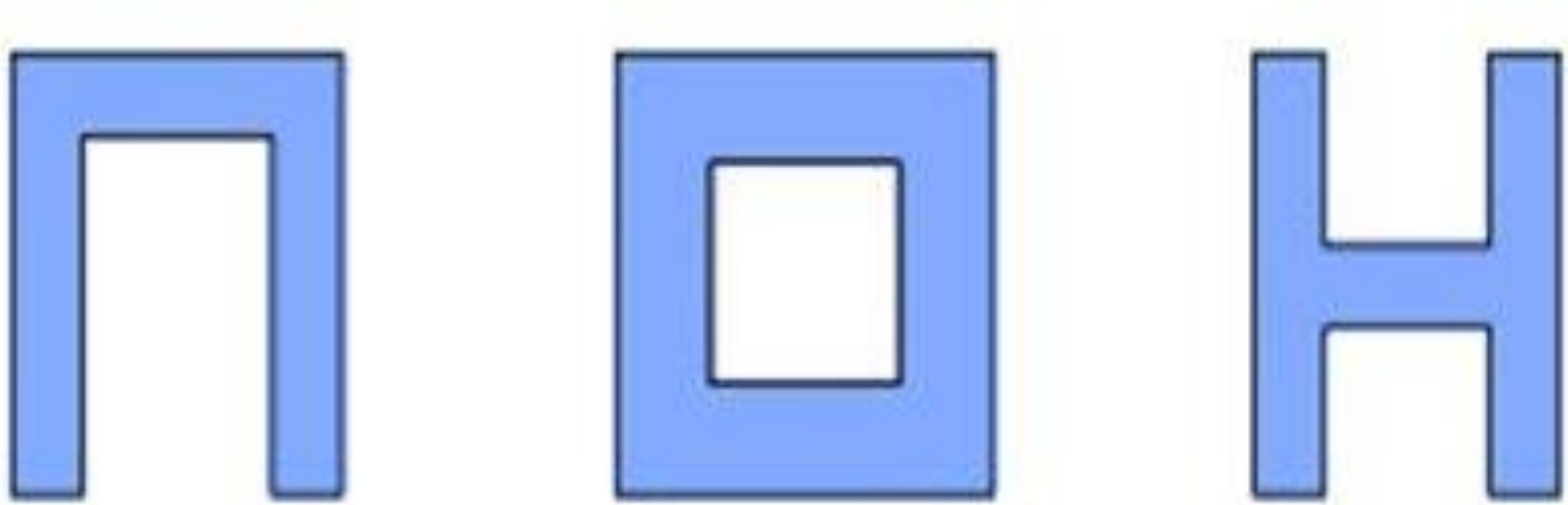

-Examples of different building layouts that can maximize daylighting

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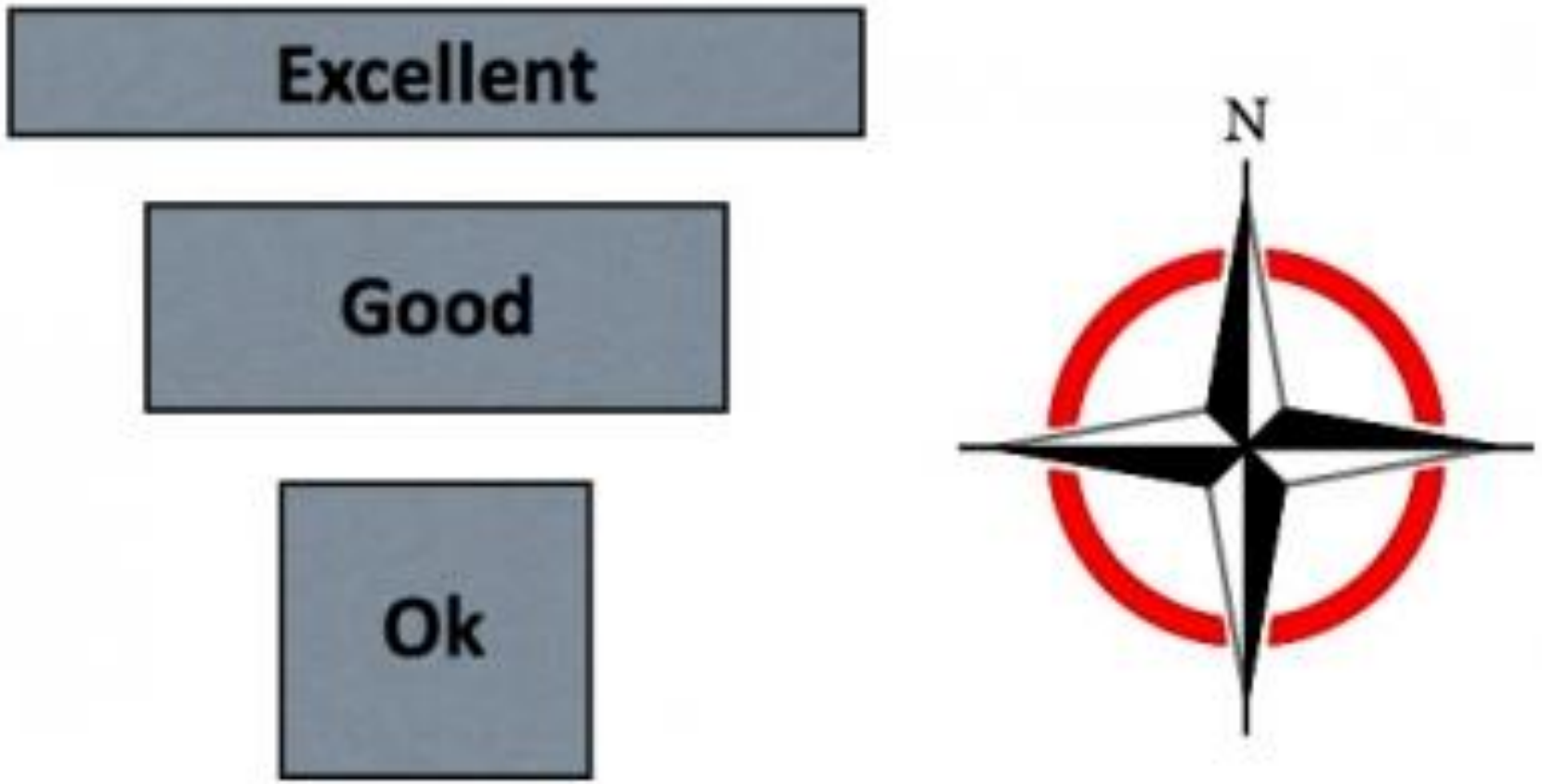

BACK

THANKS FOR THE VISIT!

- http://sustainabilityworkshop.autodesk.com/buildings/massing-orientation-heating
- https://www.nachi.org/
- http://www.usgbc.org/credits/ea51
- http://butane.chem.uiuc.edu/pshapley/Environmental/L9/1.html