How Heat Transfer Works!

To reduce heating and cooling cost and maintain a comfortable temperature a structure must be designed to make the transfer heat into or out of a structure difficult. The more difficult it is to transfer heat the less energy required to maintain the desired temperature.

What is heat? Heat is the energy transferred between objects of different temperature.

What is temperature? Temperature is the property that two objects have in common when no heat is transferred between them when placed in thermal contact.

How is heat transferred? Heat is transferred from a high temperature object to a lower temperature object while changing the internal energy of both systems involved according to the First Law of Thermodynamics. This change in internal energy causes the temperature of the objects to change except for cases such as a change of state of a material (i.e. water changing into steam). There are primarily three ways heat is transferred: conduction, radiation and convection.

Heat transfer by **CONDUCTION** occurs when heat is transferred through a material by means of molecular agitation increasing the internal energy of the object. The object does not contain heat; it merely changes its energy because of it. (i.e. heat applied to one end of a metal block at a higher temperature will be transferred down the metal block toward the colder end because the higher speed particles will collide with the slower ones resulting in a net transfer of energy to the slower ones.)

Heat transfer by **RADIATION** occurs as a result of the emission of electromagnet waves which carry energy away from the emitting object. A technical definition of electromagnet radiation is a self-propagating wave in space with electric and magnetic components. Electromagnetic radiation is classified into types according to the frequency of the wave: these types include, in order of increasing frequency, radio waves, microwaves, terahertz radiation, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays. Radiation carries energy, which may be imparted as heat when it interacts with matter. (i.e. heat transfer by radiation occurs when sunlight falls on the windshield of an automobile and heats it, when one stand close to a campfire or when a microwave oven is used.)

Heat transfer by **CONVECTION** occurs between materials that are not touching each other by mass motion of a fluid such as air or water when the heated fluid is caused to move away from the source of heat, carrying energy with it. Convection above a hot surface occurs because hot air expands, becomes less dense and rises. (i.e. the upward flow of air due to a fire or hot object or the circulation of water in a pot that is heated from below)

At what rate does heat get transferred? The rate at which heat gets transferred depends upon (1) the thickness of the material, (2) the thermal conductivity (this depends on the composition of the material), (3) surface area of the material, and 4) the temperature difference between the sides of the material.

How does heat get transferred in a building? Heat transfer from a building can occur by conduction, radiation and convection. This fact causes most of an energy budget to be spent for heating and cooling to maintain the desired temperature because heat is constantly transferring through all of the exterior surfaces of the building. Radiation loss can be minimized by using foil-backed insulation as a radiation barrier. Although infiltration through walls and around windows can contribute a significant additional loss if they are not well sealed. However, typically the most predominant type of heat transfer for the majority of buildings is conduction.

Conduction occurs when two regions of different temperature are put into direct contact, but are not allowed to mix. As an example, the inside temperature of a building in the winter is hotter than the exterior temperature if the building is being heated. The walls, doors, and windows are all conducting heat to the outside since they are in direct contact with both reservoirs of air. In most buildings, the exterior surfaces are usually comprised of more than one type of material. For instance, a wall can be composed of 3 1/2 inches of fiberglass insulation which is covered by 1/2 inches of sheetrock on the inside and plywood and brick on the exterior. When two or more different materials are between the hot and cold reservoirs, the heat transfer equation can become quite messy since there will be various thermal conductivities and thicknesses with which to deal.