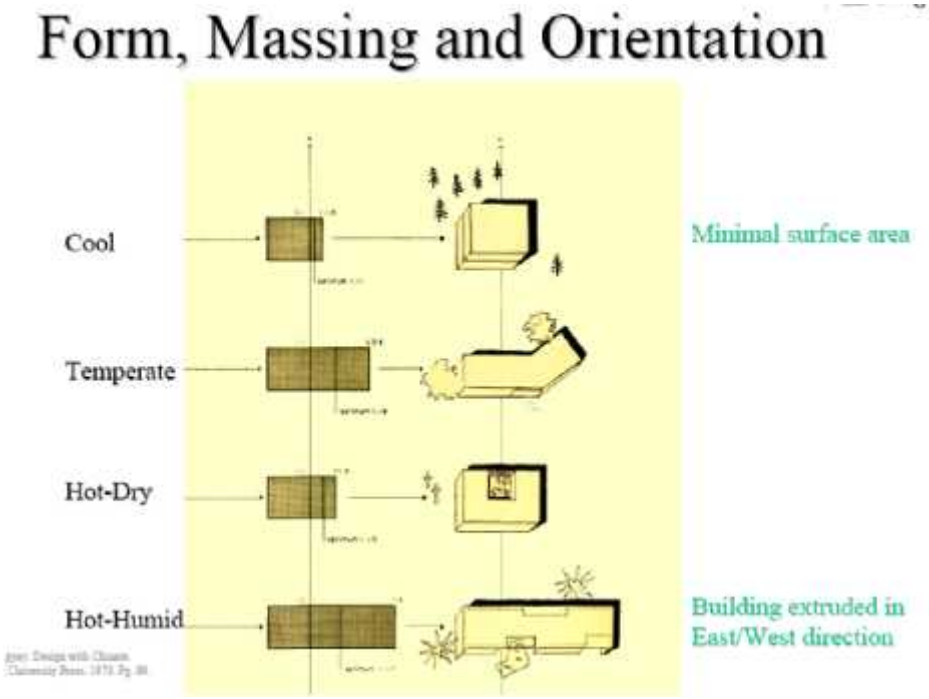
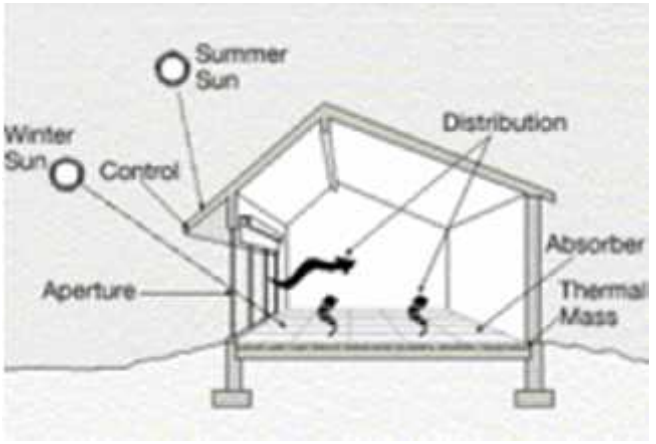
Energy conservation

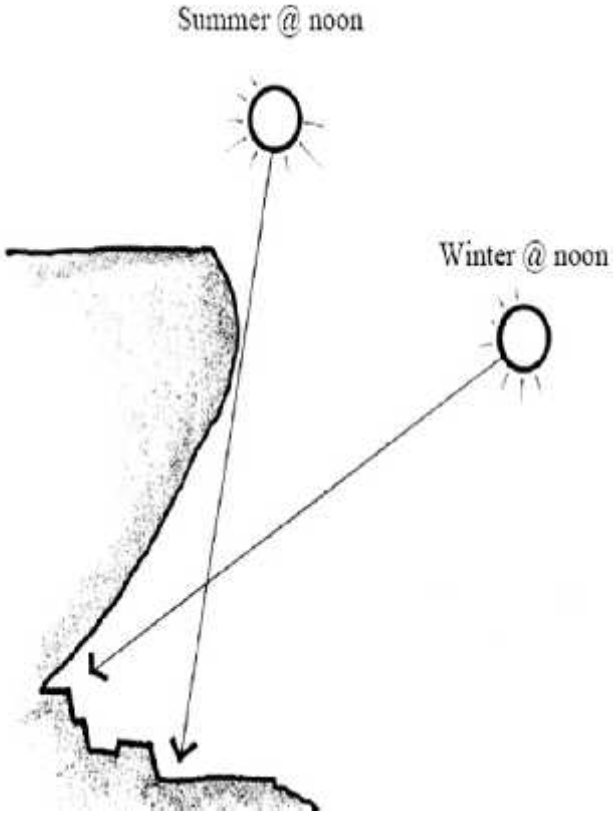




Lecture Three

Energy conservation in building corresponding to human comfort

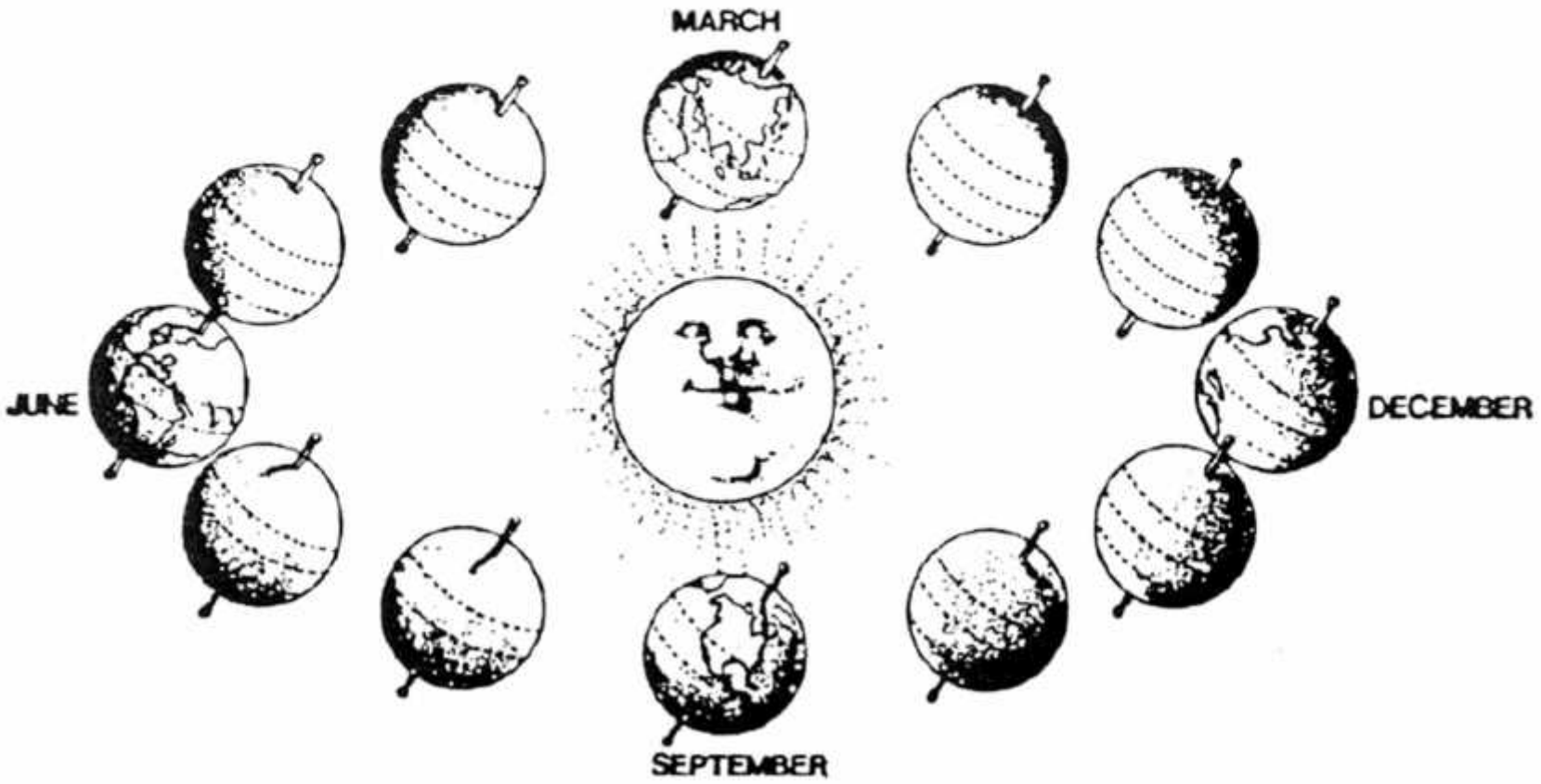
Dr.K.Al-khishali



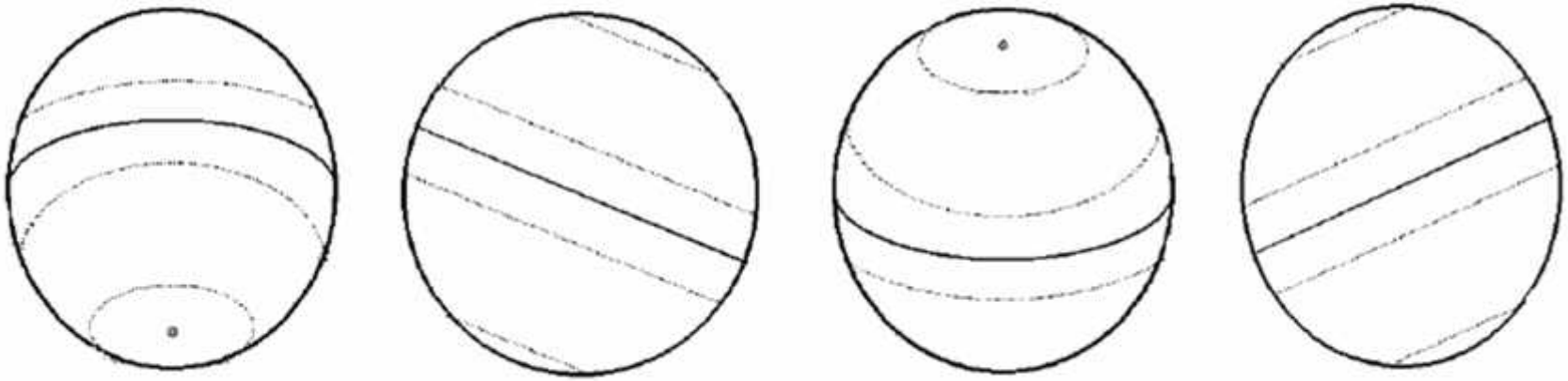
Solar Impact on Architecture

Dr.K.Al-khishali

Solar Geometry: Celestial Perspective



View of Earth from Sun

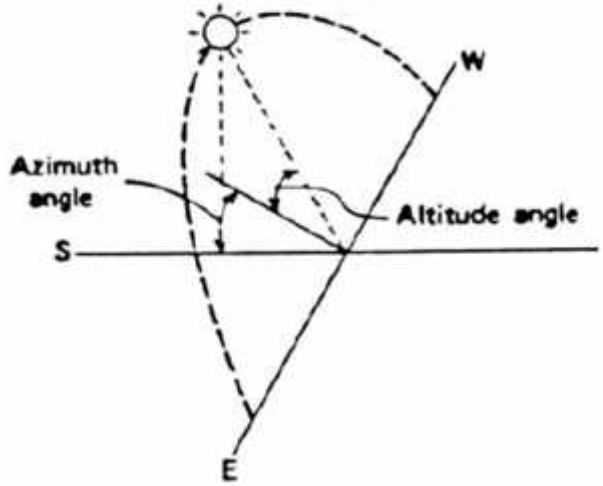


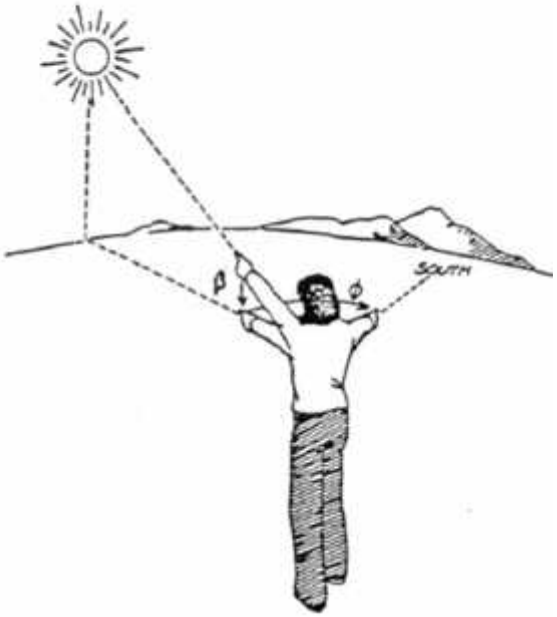
Dec.	March	June	Sept.
Shortest day in N.H.	*Equal day and night every where on planet*	*Longest day in N.H.*	*Equal day and night every where on planet*
Longest day in S.H.		*Shortest day in S.H.*	

Latitude Variation

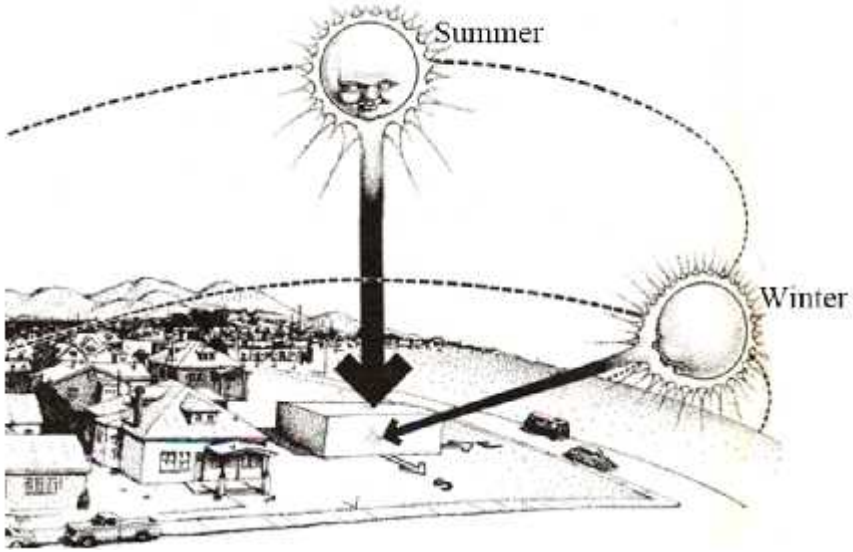
Dr.K.Al-khishali

Altitude Angle & Azimuth Angle



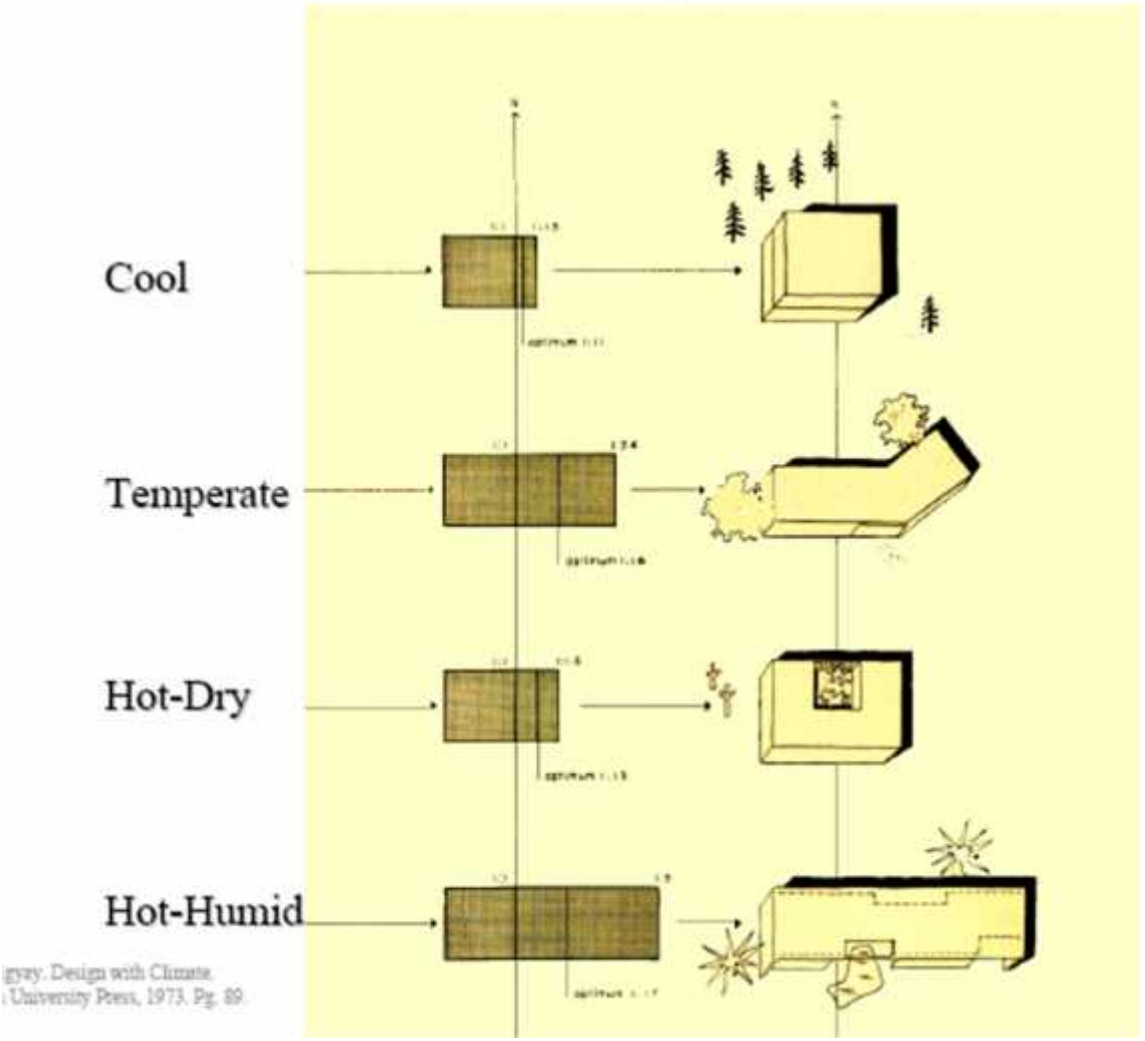


Terrestrial Perspective



Dr.K.Al-khishali

Form, Massing and Orientation



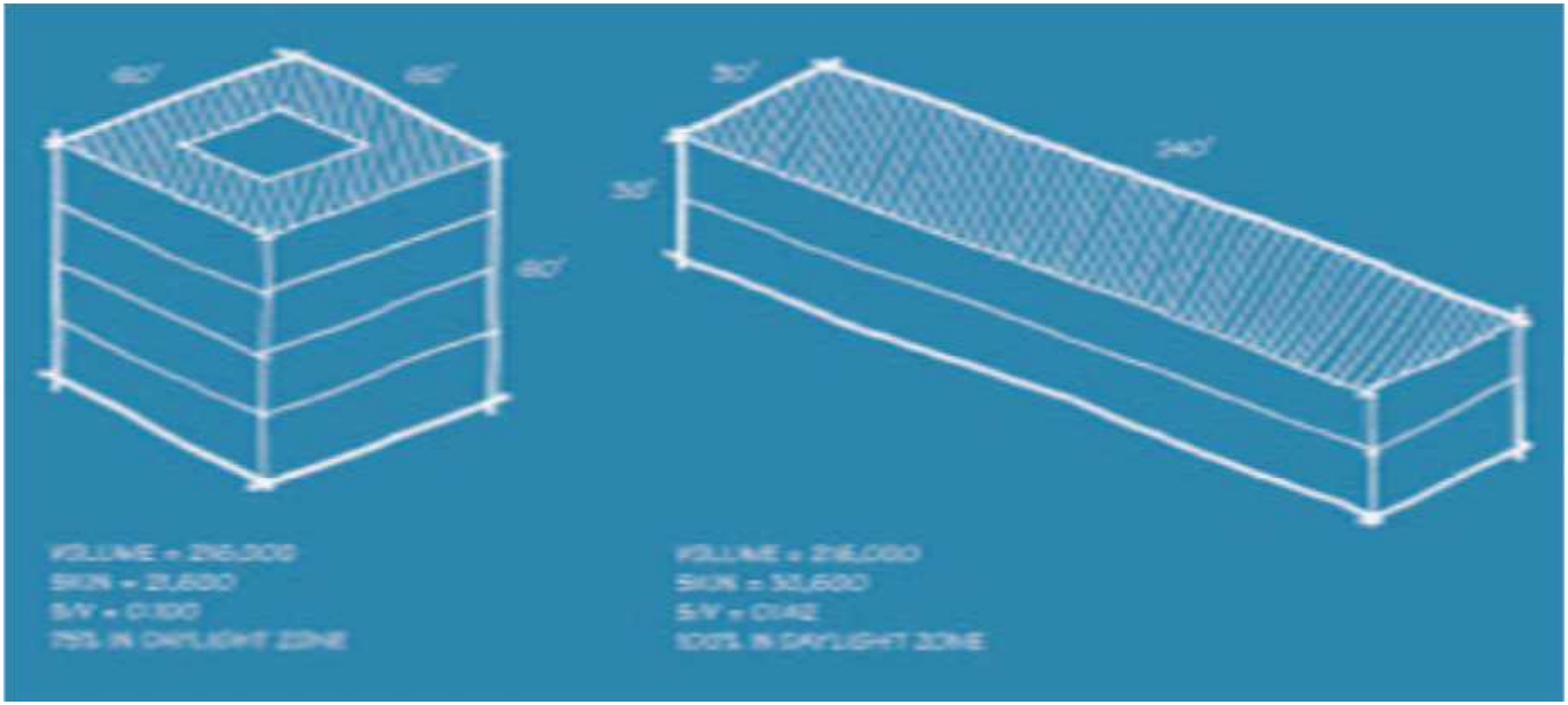
Minimal surface area

Building extruded in East/West direction

gyay. Design with Climate.
University Press, 1973. Pg. 89.

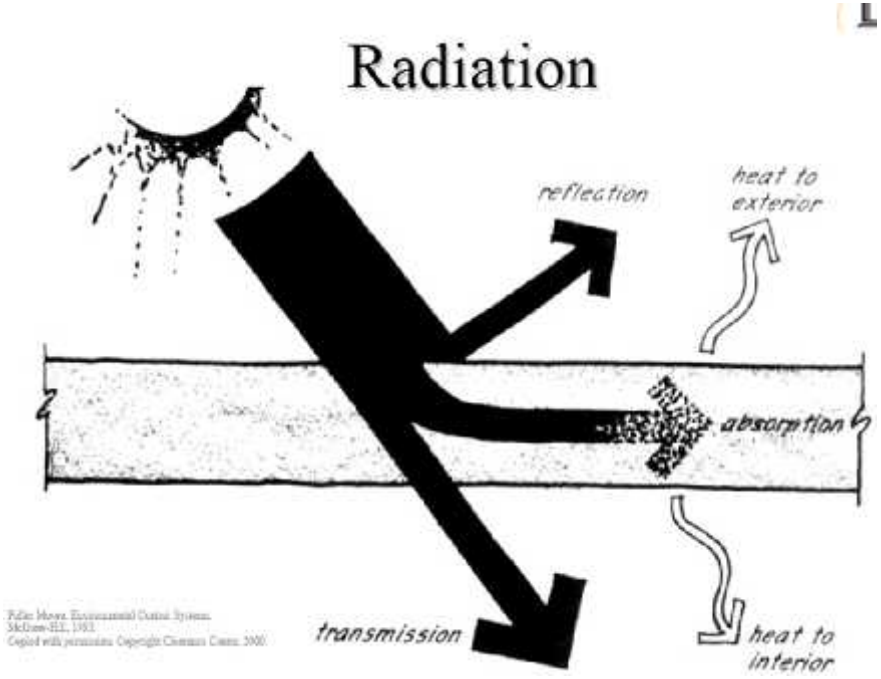
Building Massing and Orientation

There is a trade-off between a compact form that minimizes conductive heat transfer through the envelope and a form that facilitates day lighting, solar gain, and natural ventilation. **The most compact building would appropriable in the shape of a cube and would have the least losses and gains through the building skin.** However, except in very small buildings, much of the floor area in stages a square building is far from the perimeter day lighting. A building that optimizes day lighting and natural ventilation would be shaped so that more of the floor area is close to the perimeter. While a narrow shape may appear to compromise the thermal performance of the building, the electrical load and cooling load savings achieved by a well-designed day lighting system will more than compensate for the increased skin losses. Effective day lighting depends on apertures of appropriate size and orientation, with interior or exterior shading devices to control unwanted direct sunlight.-



Volume	216000	216000
Skin	21800	30600
S/V	0.1	0.148
70% daylight zone		100% DAYLIGHT ZONE

The skin-to-volume ratio is the exposed surface area compared to the building volume.

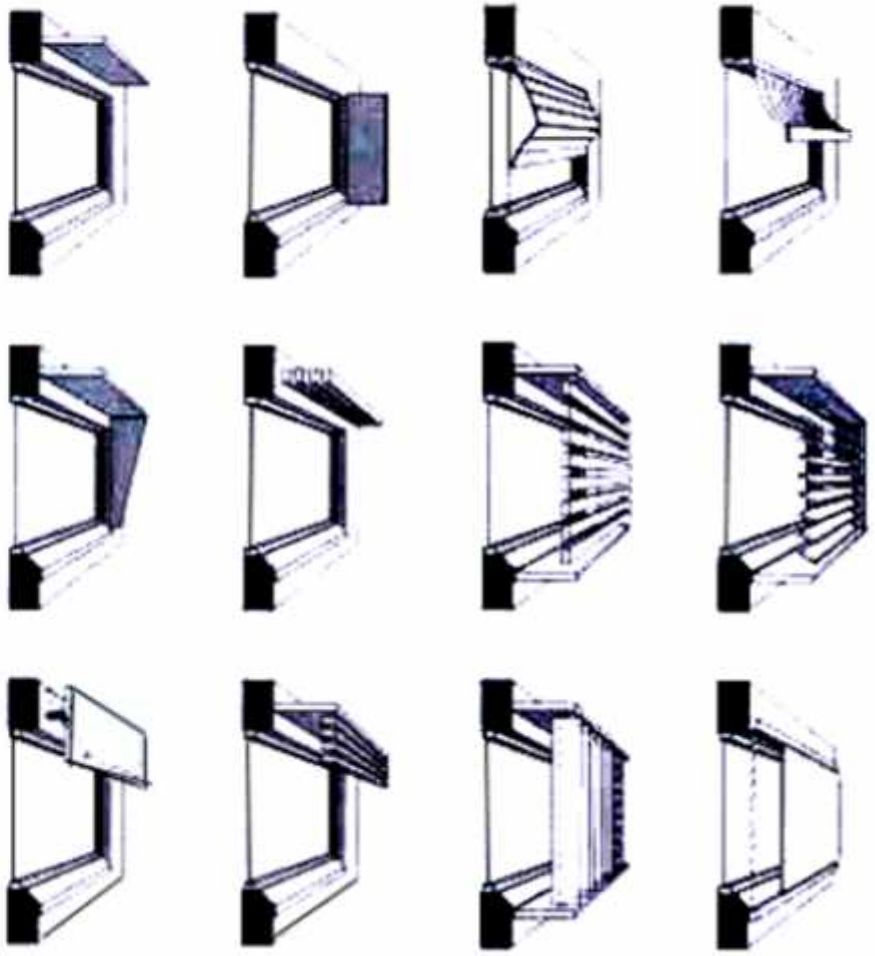


Color and Radiation

- Reflectance/Absorbtance of Solar Radiation
- Reflectance/Emissivity of Long-Wave IR Radiation

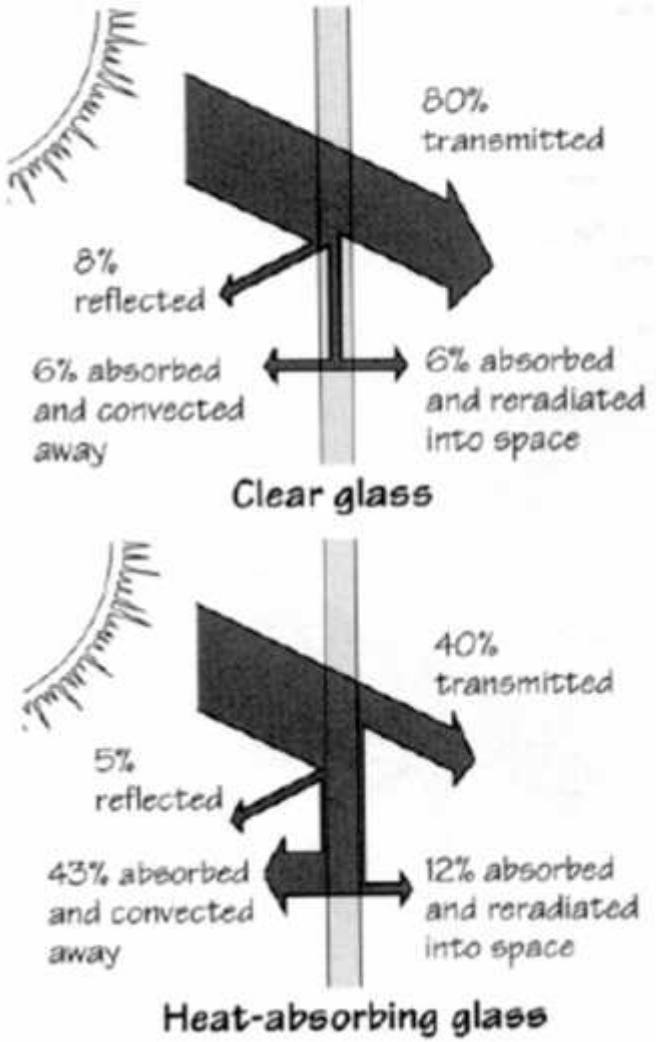
Shading Devices

- Overhangs
  - Shades overhead sun
  - South-facing glass
  - Profile angle projection
- Fins
  - Shades low-altitude angle sun
  - East or West facades
  - Azimuth angle projection



Solar Wavelengths Striking Glass Are:

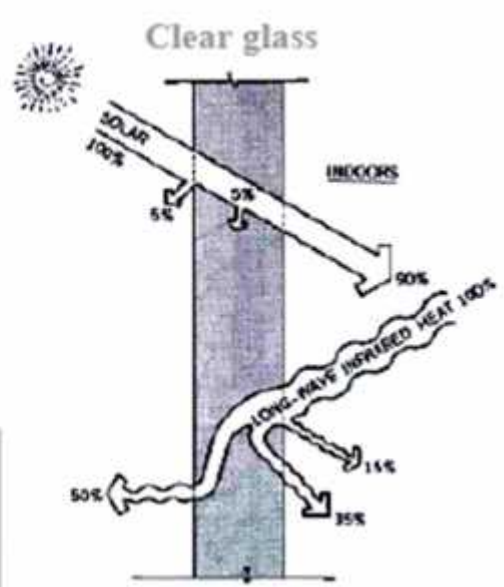
- Transmitted
- Absorbed
- Reflected

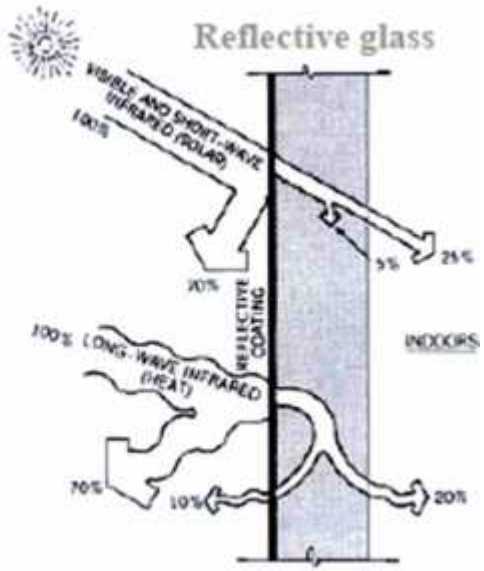


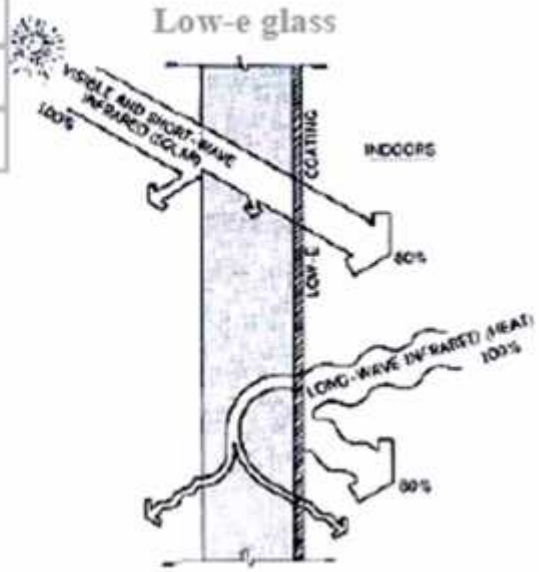
Glass Transmission

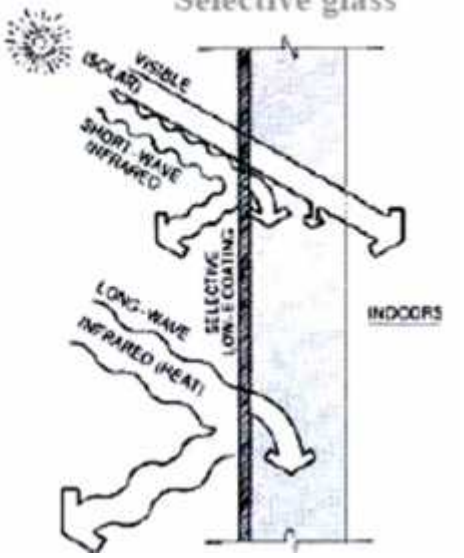
Transmits	UV	Visible light	Short wave IR (solar)	Long wave IR (earth)
Clear glass	X	X	X	X*
Reflective glass				
Low-e glass	X	X	X	
Selective glass		X		

*Absorbs and re-radiates long-wave



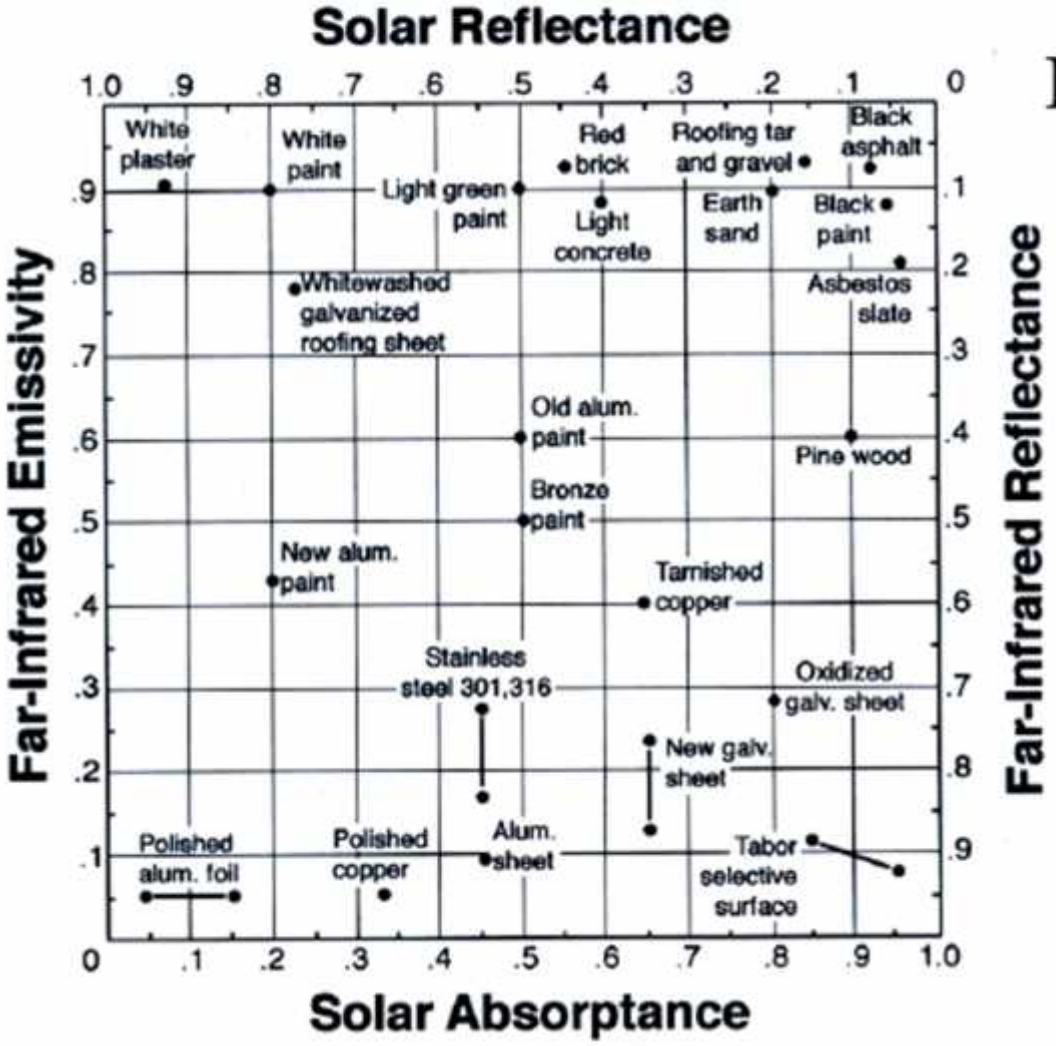






Norbert Lechner. Heating, Cooling, Lighting: Design Methods for Architects. John Wiley & Sons, 1991. Pg. 361,362.

Roof/Wall Color



Desired attributes

- High solar reflectance
- High far IR emissivity

Donald watson - editor. Time-saver standards for Architectural Design Data.

Thermal comfort

Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation(ANSI/ASHRAE Standard 55[1]).

Maintaining this standard of thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC (heating, ventilation, and air conditioning) design engineers.

Thermal comfort is affected by heat conduction, convection, radiation, and evaporative heat loss. Thermal comfort is maintained when the heat generated by human metabolism is allowed to dissipate, thus maintaining thermal equilibrium with the surroundings. It has been long recognized that the sensation of feeling hot or cold is not just dependent on air temperature alone.

Effects of thermal discomfort

Thermal discomfort has been known to lead to sick building syndrome symptoms.[3][4] The combination of high temperature and high relative humidity serves to reduce thermal comfort and indoor air quality.[3] The occurrence of symptoms increased much more with raised indoor temperatures in the winter than in the summer due to the larger difference created between indoor and outdoor temperatures.

Factors determining thermal comfort

Metabolism Physiological factors such as age, activity, sex and health.

Clothing insulation The type of clothing has strong influence on the rate of heat transfer from the human body.

Relative humidity

Draft , air motion

Radiant Temperature Asymmetry dry bulb temperature

Floor Surface Temperature surrounding surface temperature.

Vertical Air Temperature Difference

Effects of natural ventilation on thermal comfort

Operative temperature This is the average of the air dry-bulb temperature and of the mean radiant temperature at the given place in a room.

Architectural programming involves an analysis of the required spaces to meet the functional and operational needs of the facility. With an eye toward sustainability and energy-efficiency targets, the individual spaces should be clearly described in terms of their:

- **Primary functions**
- **Occupancy and time of use**
- **Daylight potential and electric light requirements**
- **Indoor environmental quality standards**
- **Equipment and plug loads**
- **Acoustic quality**

Daylighting Benefits

- Enhances the quality of luminous environment.
- Reduces energy use from lighting and can save money.
- Reduces peak demand & associated charges.
- Can reduce cooling loads.
- Connects users to natural environment and characteristics of a given place
- Potential benefits in productivity

HUMAN THERMOREGULATION

The metabolic activities of the body result almost completely in heat that must be continuously dissipated and regulated to prevent abnormal body temperatures.

Insufficient heat loss leads to overheating also called hyperthermia, and excessive heat loss results in body cooling also called hypothermia. Skin temperatures greater than 45°C or less than 18°C cause pain (Hardy 1952). Skin temperatures associated with comfort at sedentary activities are 33 to 34°C and decrease with increasing activity (Fanger 1968). In contrast internal temperatures rise with activity. The temperature regulatory center in the brain is about 36.8°C at rest in comfort and increases to about 37.4°C when walking and 37.9°C when jogging. An internal temperature less than about 28°C can lead to serious cardiac arrhythmia and death and temperatures greater than 46°C can cause irreversible brain damage. Therefore, the careful regulation of body temperature is critical to comfort and health.

Inside design conditions for Winter:

T^{op} between 20.0 to 23.5^{o}C at a RH of 60%

T^{op} between 20.5 to 24.5^{o}C at a DPT of 2^{o}C

Inside design conditions for Summer:

T^{op} between 22.5 to 26.0^{o}C at a RH of 60%

T^{op} between 23.5 to 27.0^{o}C at a DPT of 2^{o}C

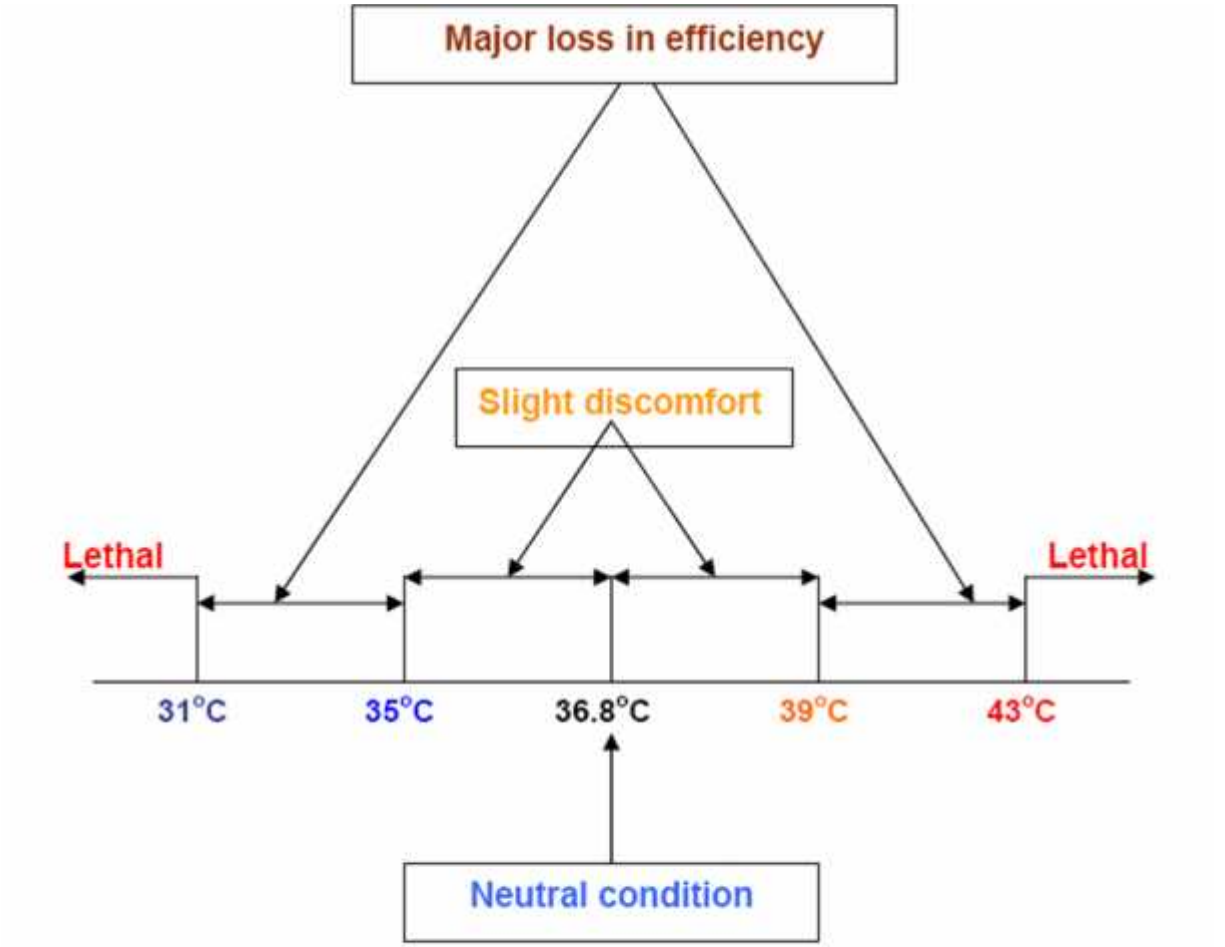


***Fig.29.2**: Affect of the variation of core temperature on a human being*

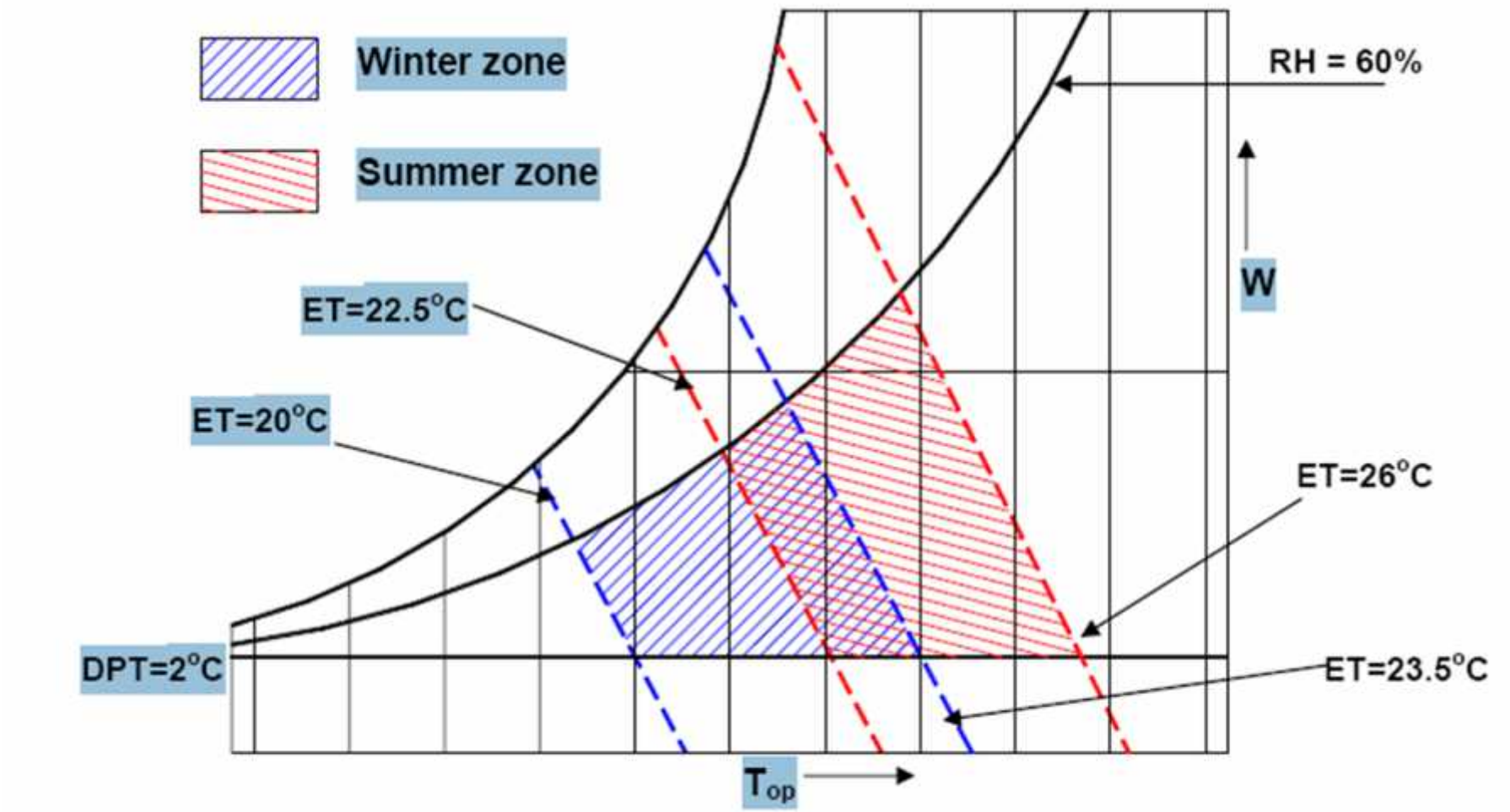
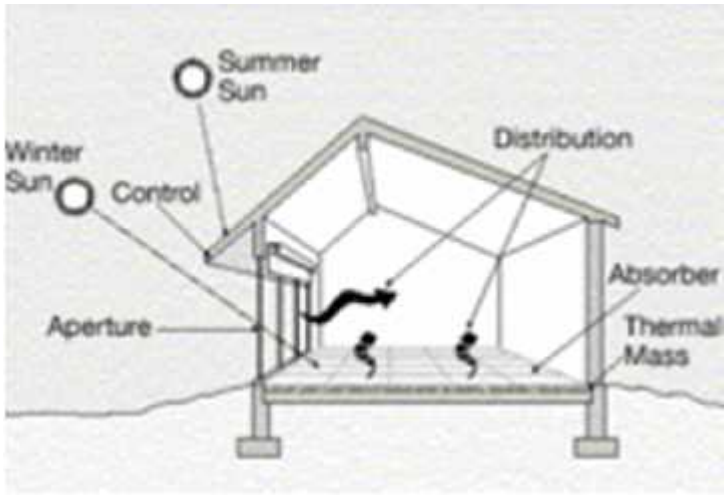


***Fig.29.3**: ASHRAE comfort chart for a sedentary person (activity ≈ 1.2 met)*

Building design

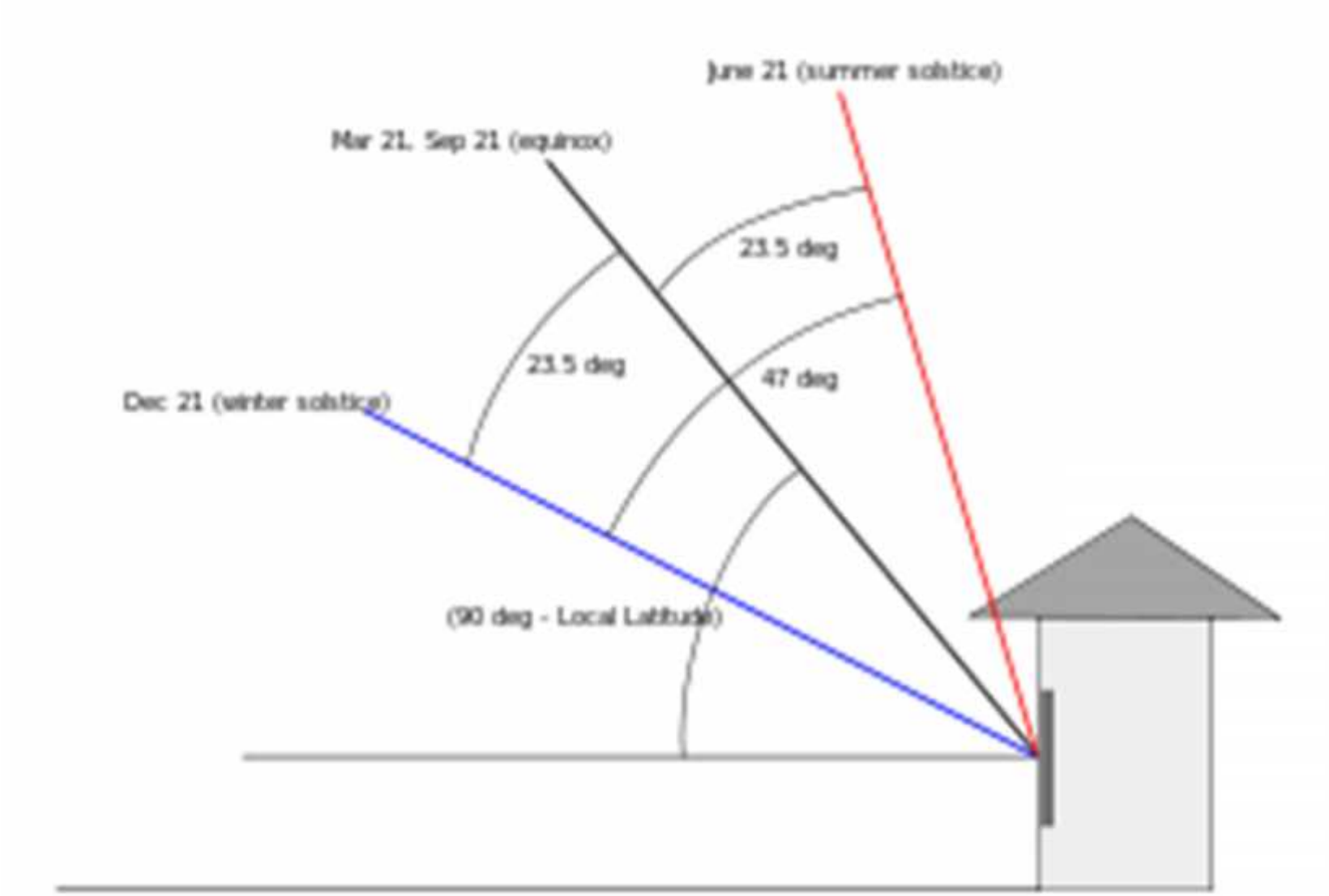


Elements of passive solar design, shown in a direct gain application

In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This is called passive solar design or climatic design because, unlike active solar heating systems, it doesn't involve the use of mechanical and electrical devices.

The key to designing a passive solar building is to best take advantage of the local climate. Elements to be considered include window placement and glazing type, thermal insulation, thermal mass, and shading. Passive solar design techniques can be applied most easily to new buildings, but existing buildings can be adapted or "retrofitted".

The solar path in passive design



Q10) Draw the view of earth from sun for months December., March, June and September.

Q11) What is the meaning of Building Form, Massing and Orientation .

Q12) What are the percentages of Solar wavelength striking a glass window?

Q13) What is the meaning of thermal comfort? What is their effects?

Q14) What are the Factors determining thermal comfort?

Q15) What is Architectural programming concerning thermal comfort?

Q16) What is Day lighting Benefits?

Q17) What is meant by HUMAN THERMOREGULATION? Draw the affect of the variation of core temperature on a human being.

Q18) Show the factors effecting building design.