Architectural Technology III

ARCH 523 | Environmental Controls

This Week's Presentation

> Review: Worksheets #4a & 4b;

> **MEEB:** *Solar Geometry and Shading Devices;*

> Worksheet #5;

> **First Analysis Project**

> This Week's Media Material: *China: From Red to Green;*

> **C+C:** *Respect Diversity*

So On With The Show!

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 1. Operative temperature is best described as:

(a) including the effects of dry bulb temperature and relative humidity

(b) the average of mean radiant temperature and air speed

(c) including the effects of dry bulb and mean radiant temperatures

(d) a temperature that describes how hot it "feels" in a space

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 2. The MET is a unit of measure that is related to:

(a) the nature of the exterior (or meteorological) climate

(b) the average surface temperature of an interior environment

(c) the rate of evaporation from a person's skin surface

(d) the level of activity in which a person is engaged

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 3. Heat exchange from the body to its surrounding environment can occur via four means of heat flow. These types of heat flow are:

Conduction;

Convection;

Radiation;

Evaporation.

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 4. The "adaptive" model of thermal comfort suggests that:

(a) information technology can be used to adapt building conditions to meet the desires of the occupants

(b) people can be expected to take actions to improve their own thermal comfort

(c) the body will automatically adjust heat loss and gain to suit the surrounding conditions

(d) psychological comfort factors are at least twice as important as physical factors

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 5. ASHRAE's most notable involvement in comfort issues is through:

(a) its publication of a thermal comfort standard (Standard 55)

(b) its development of the bioclimatic chart and timetable of climatic needs

(c) its publication of guidelines for design of passive cooling and heating systems

(d) actually, ASHRAE has no involvement with thermal comfort

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 6. Olgyay's "climatic timetables" for various cities present:

(a) information that relates thermal comfort and annual climate conditions

(b) schematic diagrams of numerous passive heating and cooling approaches

(c) dates and times of all extreme weather occurrences

(d) information that relates thermal comfort to building occupancy schedules

Last Week: **Comfort and Design Strategies** (Chapter 4)

Worksheet #4a

... 7. Order the following passive heating design approaches from architecturally simplest to architecturally most complex: *indirect gain, isolated gain, and direct gain.*

Direct Gain —> Indirect Gain —> Isolated Gain

Last Week: **Indoor Air Quality** (Chapter 5)

Worksheet #4b

... 1. Problems with poor indoor air quality in buildings seem to be increasing because:

(a) the quality of the exterior air surrounding most buildings has decreased dramatically

(b) more aggressive indoor pollutants have developed due to global warming

(c) we spend more time indoors—in tighter buildings with more artificial materials

(d) material scarcities have resulted in the use of less efficient air filters

Last Week: **Indoor Air Quality** (Chapter 5)

Worksheet #4b

... 2. Which of the following best describes the sources of pollutants normally found in buildings:

(a) occupants, finishes, furnishings, and stored chemicals

(b) walls, floors, ceilings, and fenestration

(c) processes, equipment, occupants, finishes, and furnishings

(d) irritants, odors, and toxics

Last Week: Sites and Resources (Chapter 5)

Worksheet #4b

... 3. Which of the following best describes the general approaches to providing good IAQ:

(a) source control, filtration, exhaust, dilution, and maintenance

(b) panel filters, exhaust fans, dehumidifiers, and heat exchangers

(c) passive or active ventilation

(d) arrestance, adsorption, adhesion, and replacance

Last Week: **Indoor Air Quality** (Chapter 5)

Worksheet #4b

... 4. Outgassing as an IAQ concern refers to:

(a) the recharge cycle of desiccant dehumidifiers

(b) an unfortunate outcome of occupants eating some types of foods

(c) the tendency of electronic air cleaners to reverse polarity and dump collected dust

(d) the release of volatile organic compounds by finishes and furnishings

Last Week: **Indoor Air Quality** (Chapter 5)

Worksheet #4b

... 5. The stack effect is dependent upon which of the following:

(a) a temperature difference and a vapor pressure difference

(b) a temperature difference and a difference in elevation

(c) a difference in elevation and a narrow pipe or chase

(d) a continuous heat source (a fire or solar collector) and a difference in elevation

Last Week: Sites and Resources (Chapter 5)

Worksheet #4b

... 6. "Sick building syndrome" is best described as:

(a) a collection of ailments that seems to be associated with occupancy of a building

(b) an infectious disease particularly prevalent in passive solar buildings

(c) a rash that is experienced by occupants in mechanically conditioned buildings

(d) the biological growths in a building (generally called mold and mildew)

Last Week: Sites and Resources (Chapter 3)

Worksheet #3b

... 7. "Ventilation" is best described as:

(a) the circulation of air in an enclosed space

(b) the circulation of air through a filtration system or device

(c) the introduction of outdoor air into a building

(d) the removal of moisture from the air by refrigerants or desiccants

This week... Thermal Control

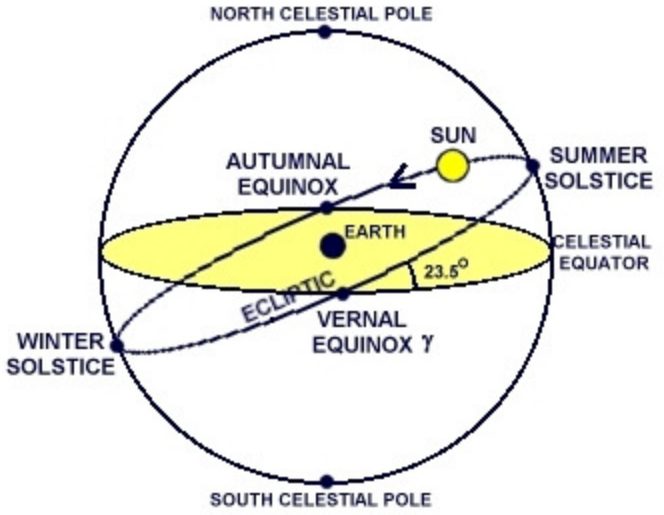
Solar Geometry and Shading Devices

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: Here Comes the Sun

The sun's position during the course of the day is among the most critical factors to consider when planning one's site and building.

The patterns of the sun's movement, recurring both daily and throughout the year's seasons, provides positive geometric constraints as well as a source of energy to be used by our Environmental Systems.



This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position

The Source of the Sun's Energy: Nuclear Fusion

- Spectrum of Sun Light includes:
  - 5% Ultraviolet and shorter wavelengths...
  - 46% Visible light (350-750 nm)...
  - 49% Infrared and longer wavelengths.

- Heat Energy arriving at the Earth: **Solar Constant**
  433 Btu/ft^2 per hr

The Solar Constant is constant *throughout the year. But the length of solar radiation's path through the atmosphere largely determines the strength of the* received *radiation:* **Insolation.**

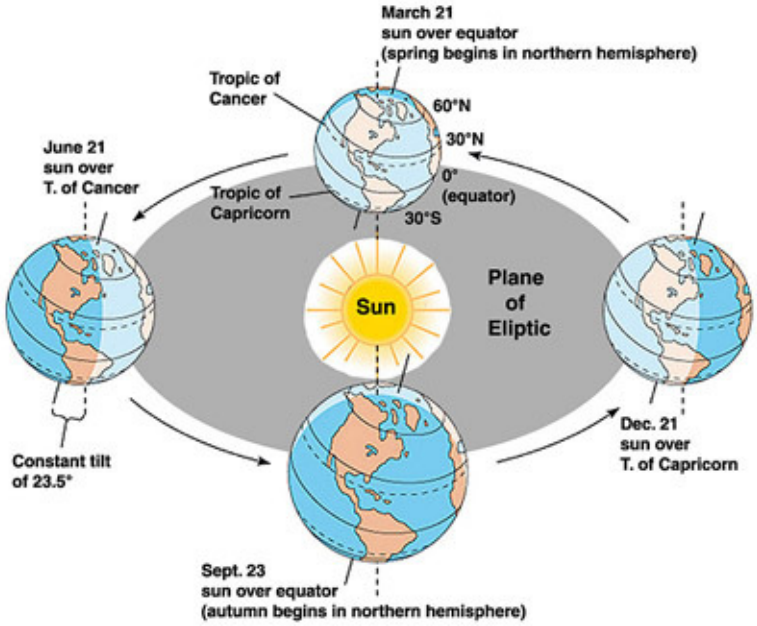
This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position

A) The Earth's Rotation and Tilt

> **Declination** (tilt) : 23.5 Degrees

> **Ecliptic**: Plane of Earth's Orbit



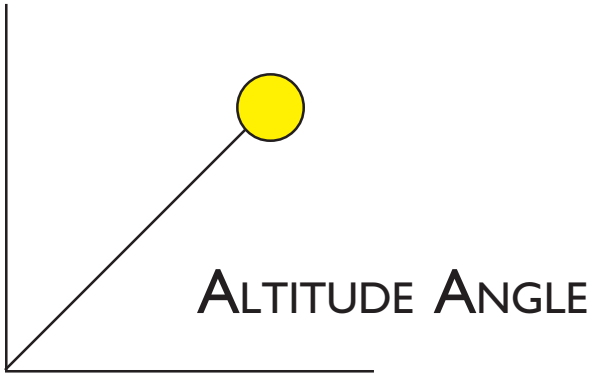
The different seasons are due to the Earth's Declination.
When the northern hemisphere is tilted towards the sun, the path of solar radiation through the atmosphere is at its shortest and closest to perpendicular: Summer. When the northern hemisphere is tilted away from the sun, the path of radiation through the atmosphere is longer and at a more oblique angle to the ground.

This week... Thermal Control | Solar Geometry and Shading Devices

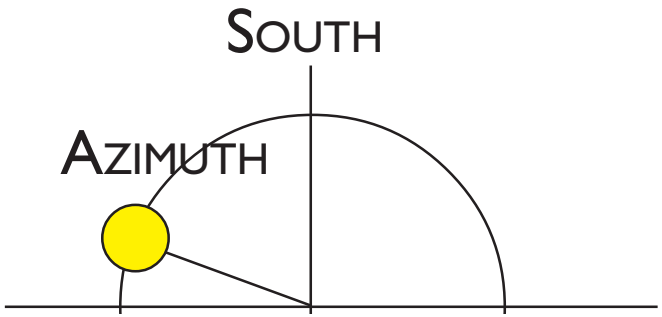
MEEB: The Sun and Its Position: Altitude and and Azimuth

> **Altitude Angle**: Angle between the horizon and the Sun's position in the Sky... *How high the sun is in the sky.*

> **Azimuth (Solar Bearing Angle)**: Angle along the horizon between the projected position of the sun and solar south. *What "time" is it relative to noon...*



Section View



Plan View

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Altitude and and Azimuth

> *Sun's Altitude Angle depends on latitude and changes with the seasons.*

> *Sun's Azimuth depends on hour of observation and ALSO changes with the seasons.*

1) Sun's Altitude is highest in the Summer, lowest in the Winter, and in-between in the Spring / Fall (Equinox) ; maximum difference between Summer and Winter (Solstice) is about 47 degrees.

2) Daily Maximum Altitude increases as one moves towards the Equator; yet seasonal variation is the same for all latitudes. Altitude affects both design of sun-shading devices but also exterior daylight levels.

3) Azimuth Angle is an important consideration for building orientation, determining building exposures, and analyzing shading angles.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Solar Versus Clock Time

> *One "day" equals one Earth rotation; nevertheless, three factors exist which effect a difference between Solar Time and Clock Time:*

1. *Location within a time zone... Obviously!*

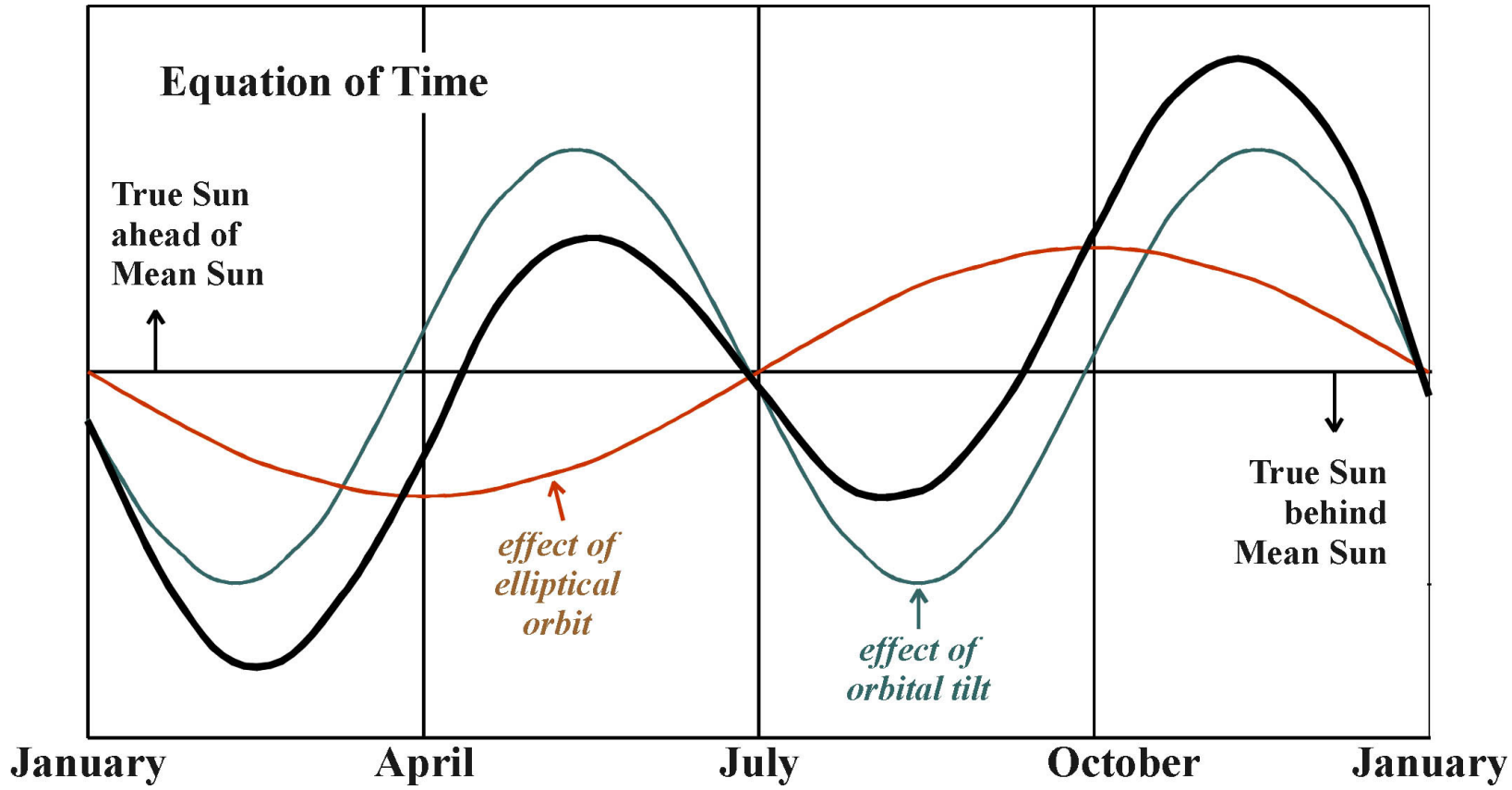
2. *Daylight Saving Time...Naturally!*

3. *And...*

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Solar Versus Clock Time

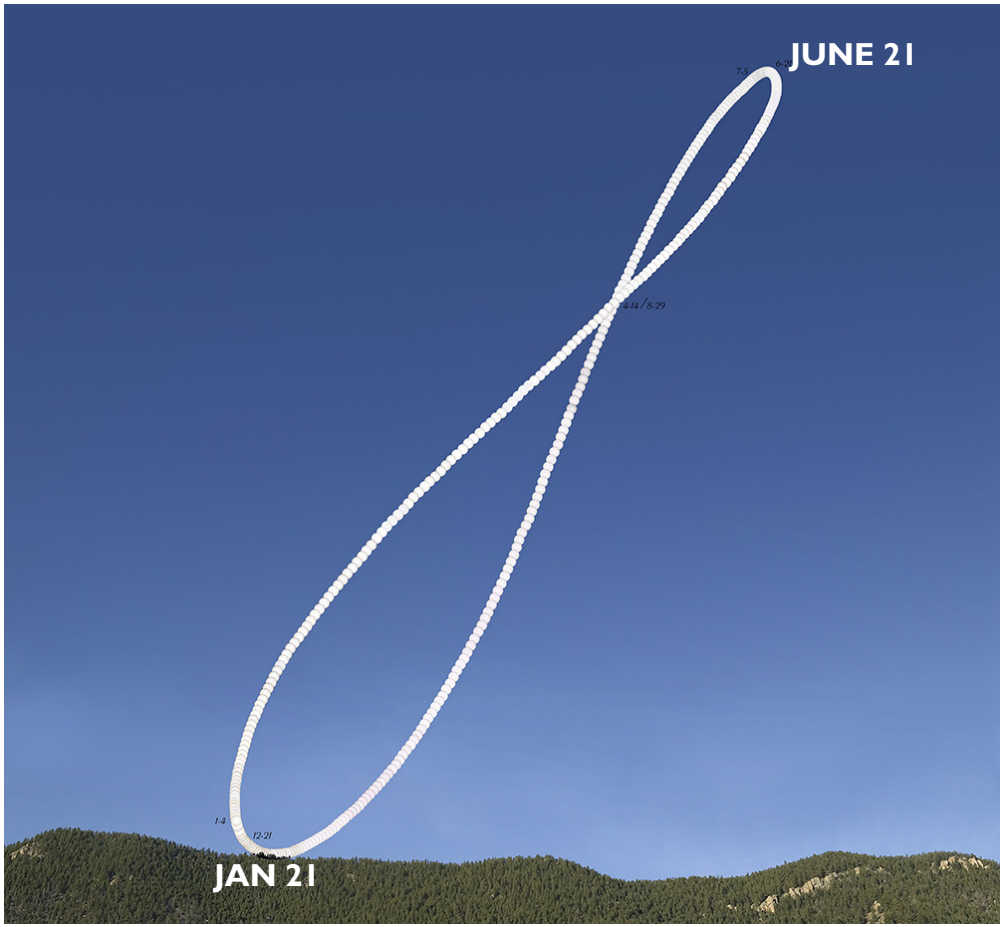
3. *Equation of Time: Offset of "noon" due to location along elliptical orbit and the effect of orbital tilt...*



This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Solar Versus Clock Time

The physical effect of the "equation of time" can be understood by study of the Analemma, a curve which illustrates the location of the sun in the sky at the same time of day each day of the year:



This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: True / Magnetic South

> Planning for Sun-sensitive design depends upon "True" South," the opposite of "True North," which marks the axis of the Earth's Rotation.

> A compass, however, points towards **magnetic** north.

An empirically-derived magnetic "deviation" correction must be applied to compass readings. The appropriate deviation is relative to both the magnetic north and a particular site's location. Earth's magnetic field is not static, and changes over time; the required "magnetic deviation" must also be adjusted over time.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Sunpath Projections

> Represents the Sun's position throughout the year, at a certain location (latitude) on the Earth.

Four common types of sunpath projects are:

1) Gnomonic;

2) Equidistant;

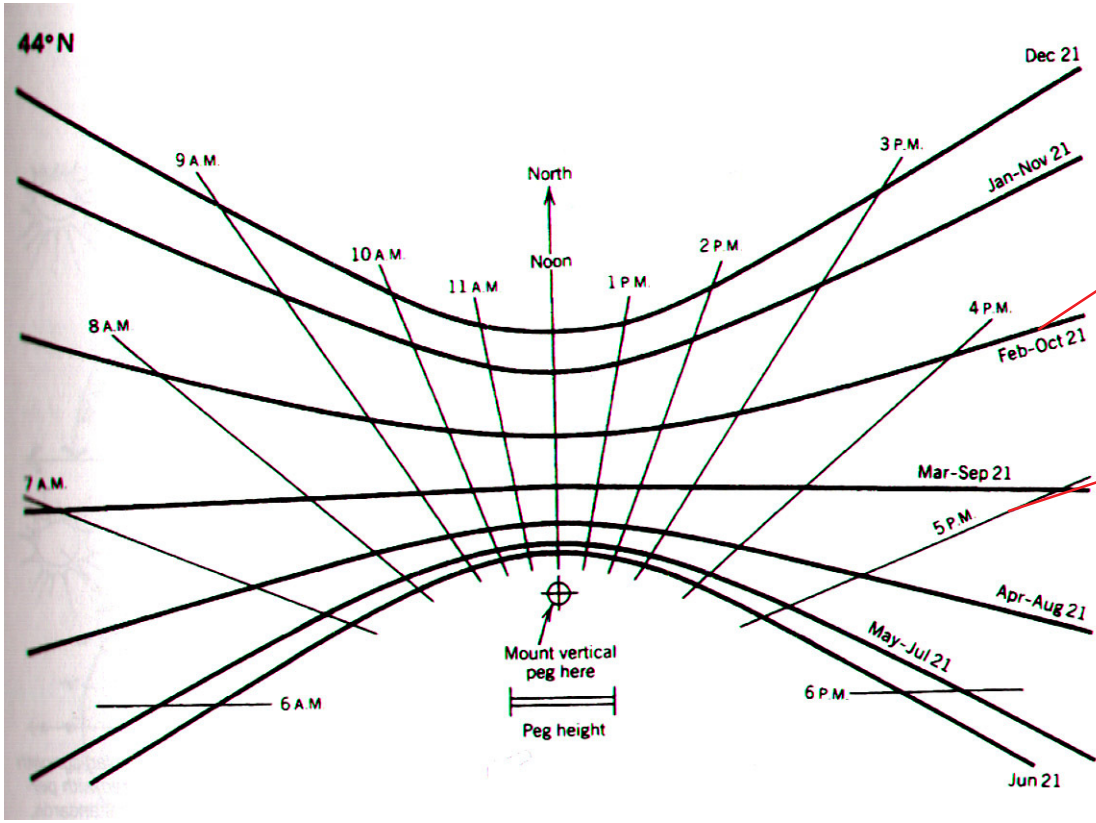
3) Rectilinear;

4) Stereographic (Looks similar to the "Equidistant" type.)

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Sunpath Projections
Gnomonic

Gnomonic Projection is used with sundials and "sunpeg" charts. "All great circles are straight lines". Gnomonic Projection is used often for orienting Models.



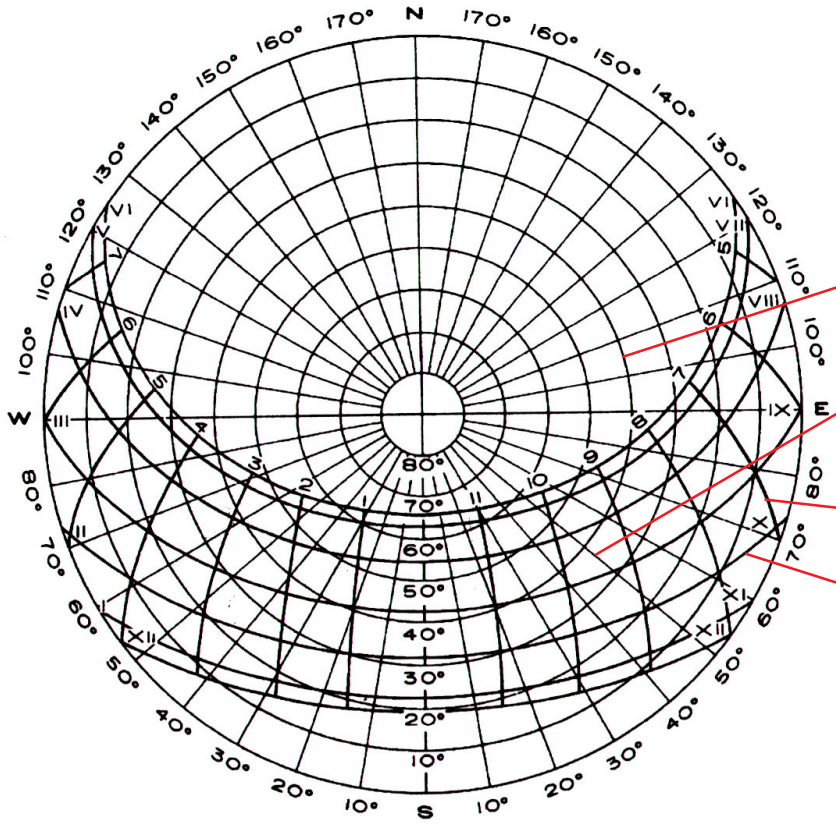
Sunpath Isoline
(21st of each Month)

Hour Isoline

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Sunpath Projections
Equidistant

Equidistant Projection is used mostly in the US, due to wide acceptance of a vendor's analysis tool.



(g) **48°N LATITUDE**

Altitude

Azimuth

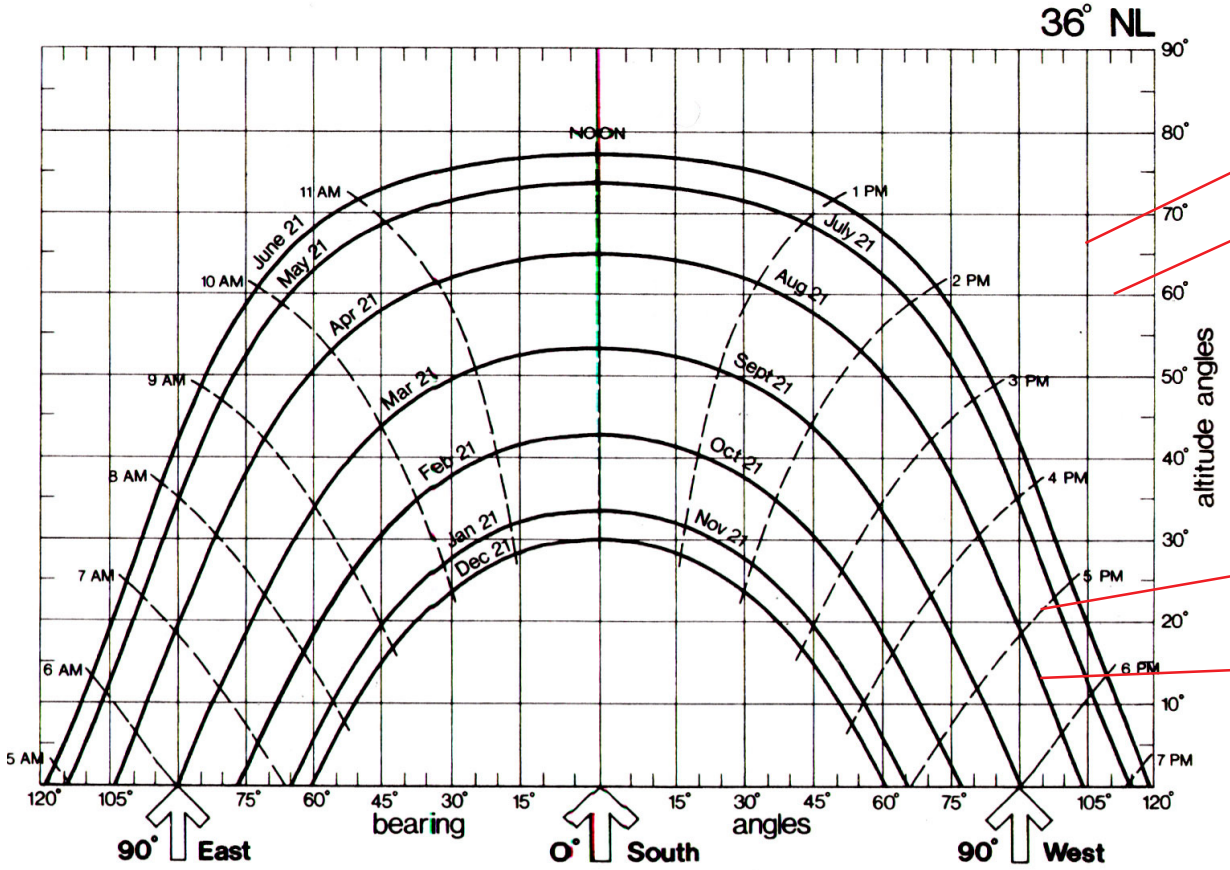
Hour Isoline

Sunpath Isoline
(21st of each Month)

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Sunpath Projections
Rectilinear

Equidistant Projection is a two-dimensional graph of the Sun's position:



Azimuth

Altitude

Hour Isoline

Sunpath Isoline
(21st of each Month)

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading

> Shading windows from solar gain represents the primary tool for the control of solar energy in architecture.

> Shading opaque wall areas should remain a consideration.

> Most shading operates on South, West, and East-facing surfaces; nevertheless, North-facing surfaces *are* subject to insolation and might require shading devices.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading

> Shading for Orientation

South-facing *surfaces: horizontally-oriented shading.*
East / West -facing *sufaces: vertically-oriented shading.*

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading

> Operable Shading Devices
Respond to both seasonal changes and daily/hourly changes.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shadow Angles
Shading Masks

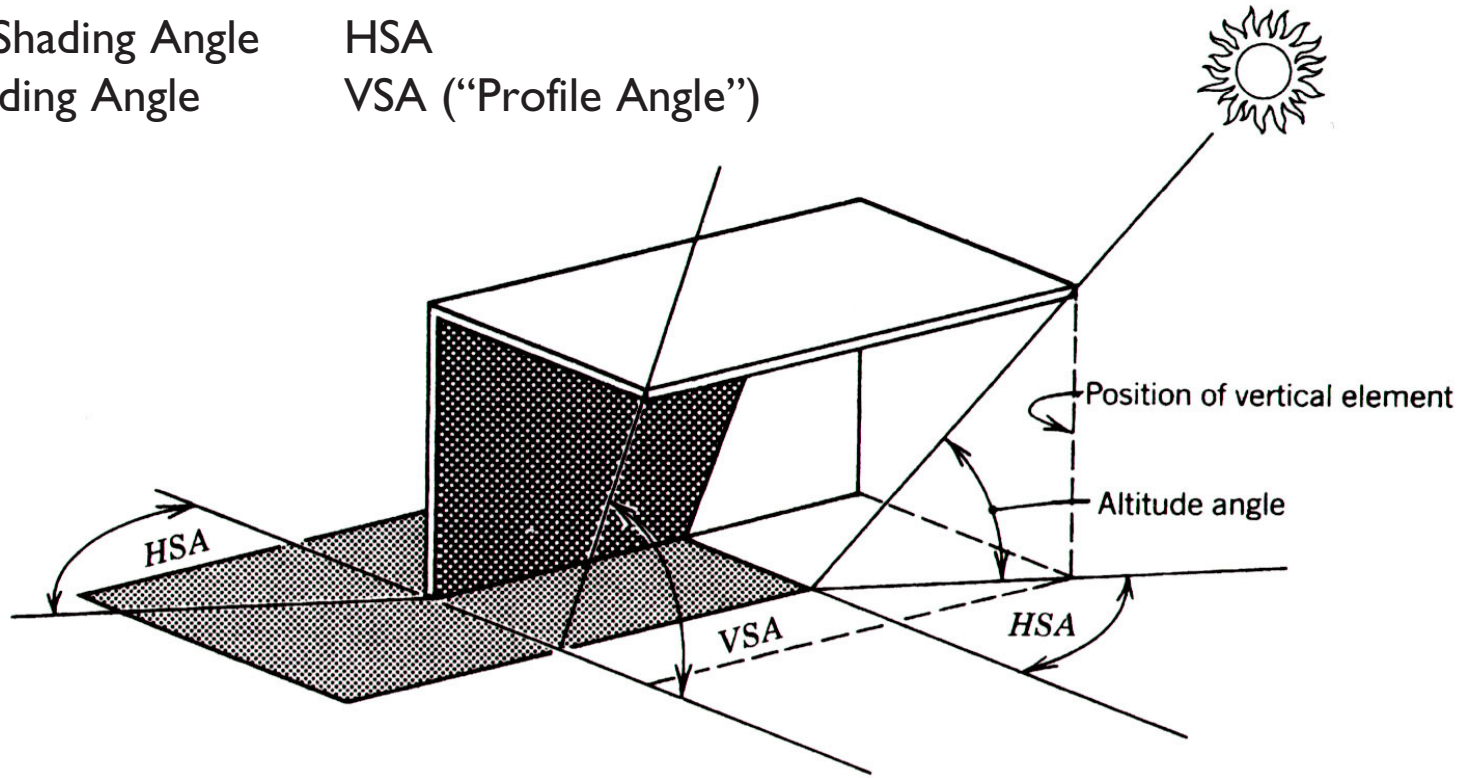
Understanding the unobstructed path of the sun is obviously important; but it is only a small part of the story. Just as significant is the impact of shadows which restrict the introduction of solar energy into the building. These shadows can be understood by studying their projections from the point of obstruction to the vertical or horizontal surface upon which the shadows fall.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shadow Angles

The complexity of shading, involving multiple factors and angles, requires precision in the nomenclature of each item.

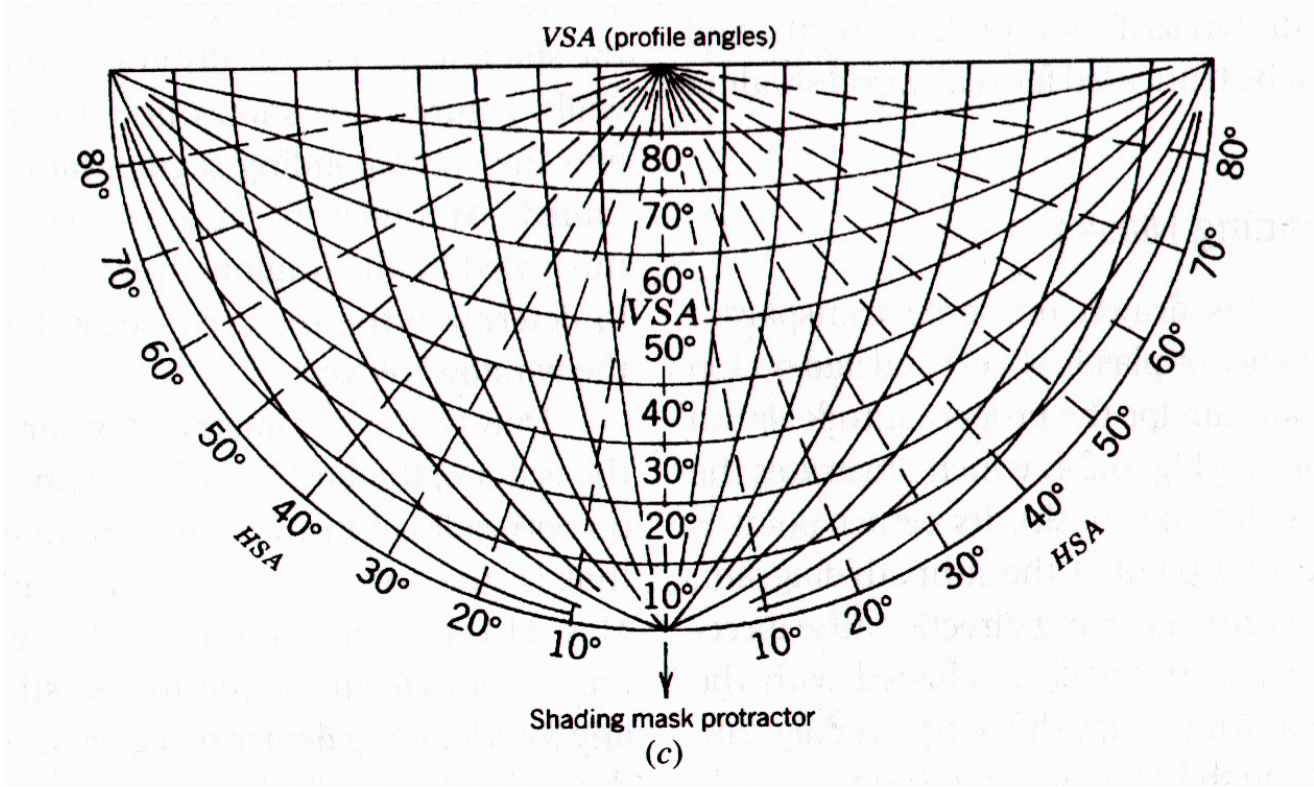
Horizontal Shading Angle HSA
Vertical Shading Angle VSA ("Profile Angle")



This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Masks

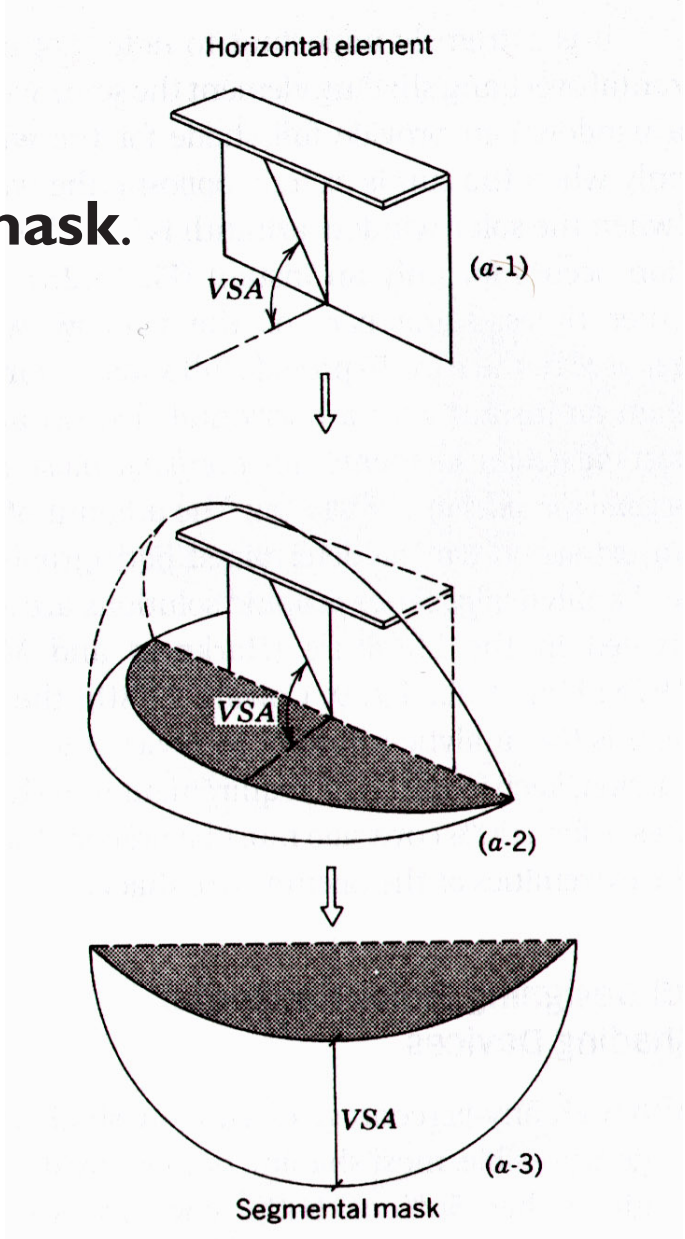
"A Shading Mask is a sunpath chart that shows the shadow cast by a particular shading device." p.165 A Shading Mask Protractor may be used to plot the masks properly...



This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position

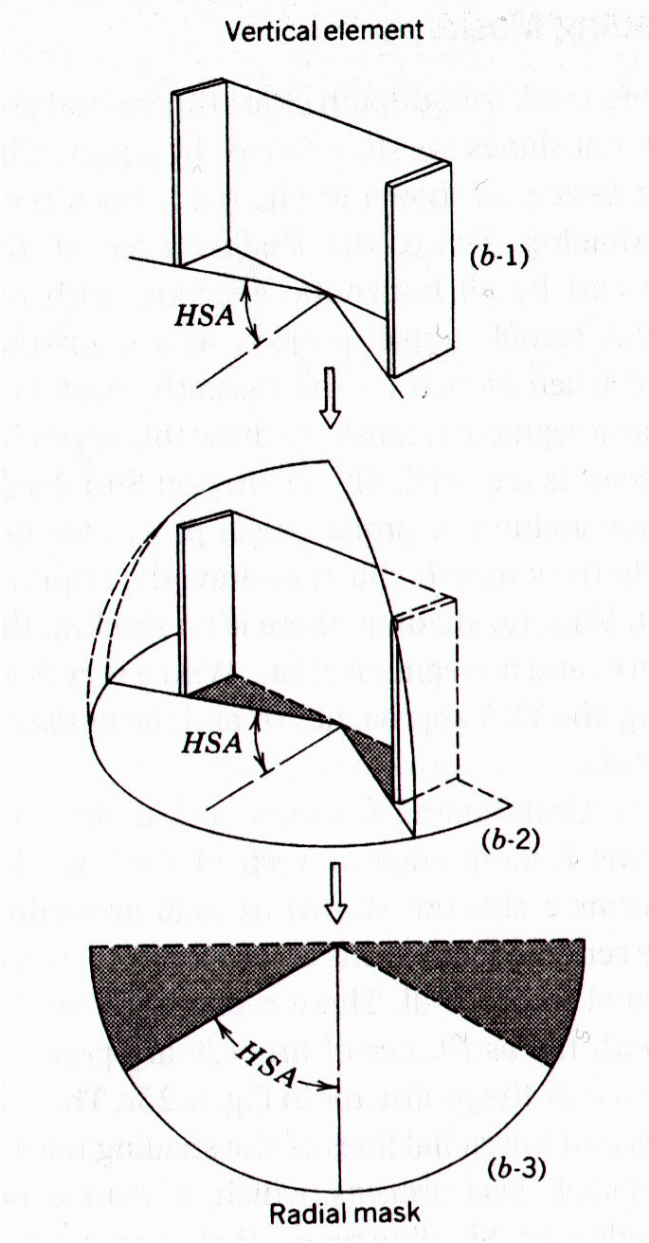
Horizontal elements produce a **segmental mask**.



This week... Thermal Control | Solar Geometry and Shading Devices

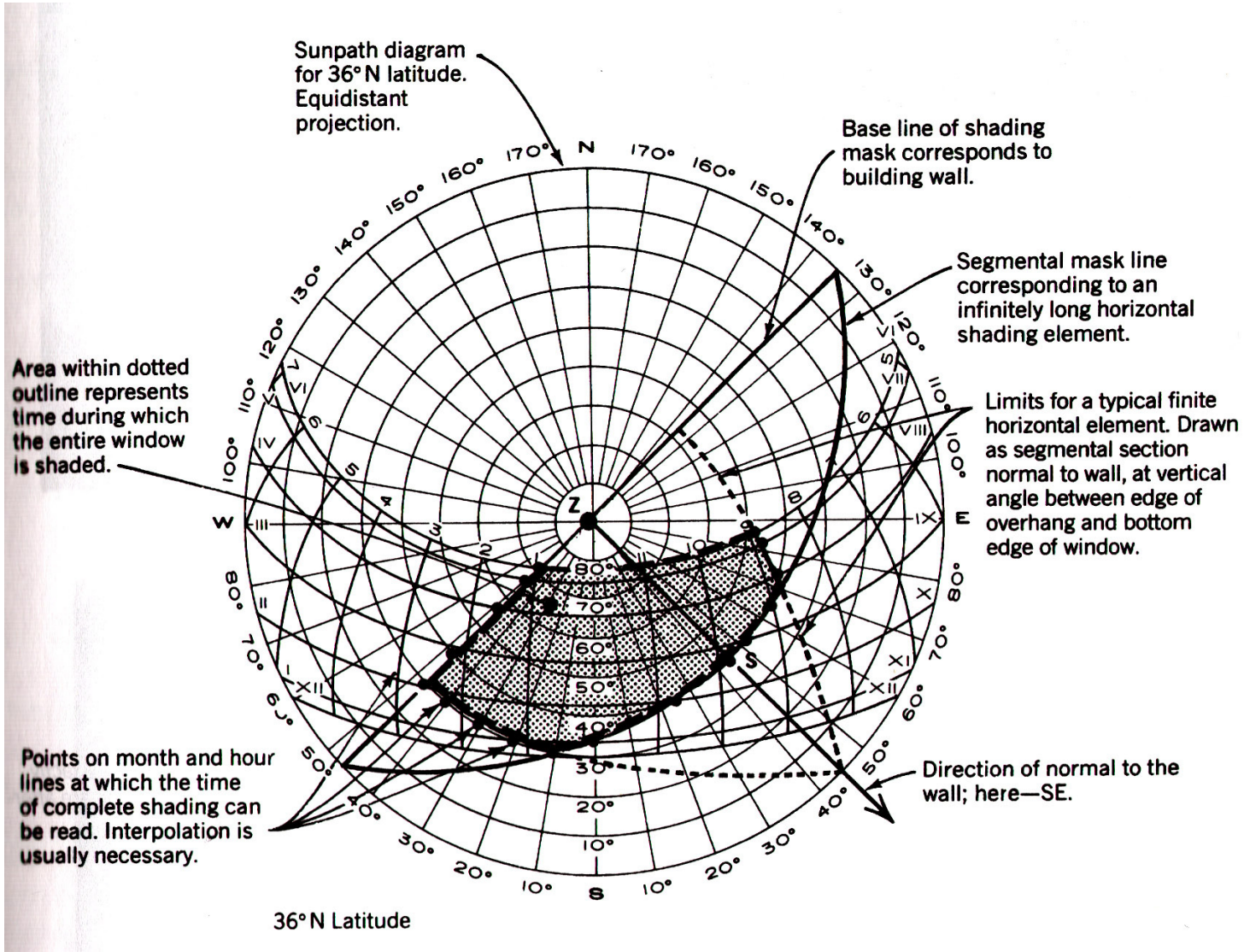
MEEB: The Sun and Its Position

Vertical elements produce a **radial mask**.



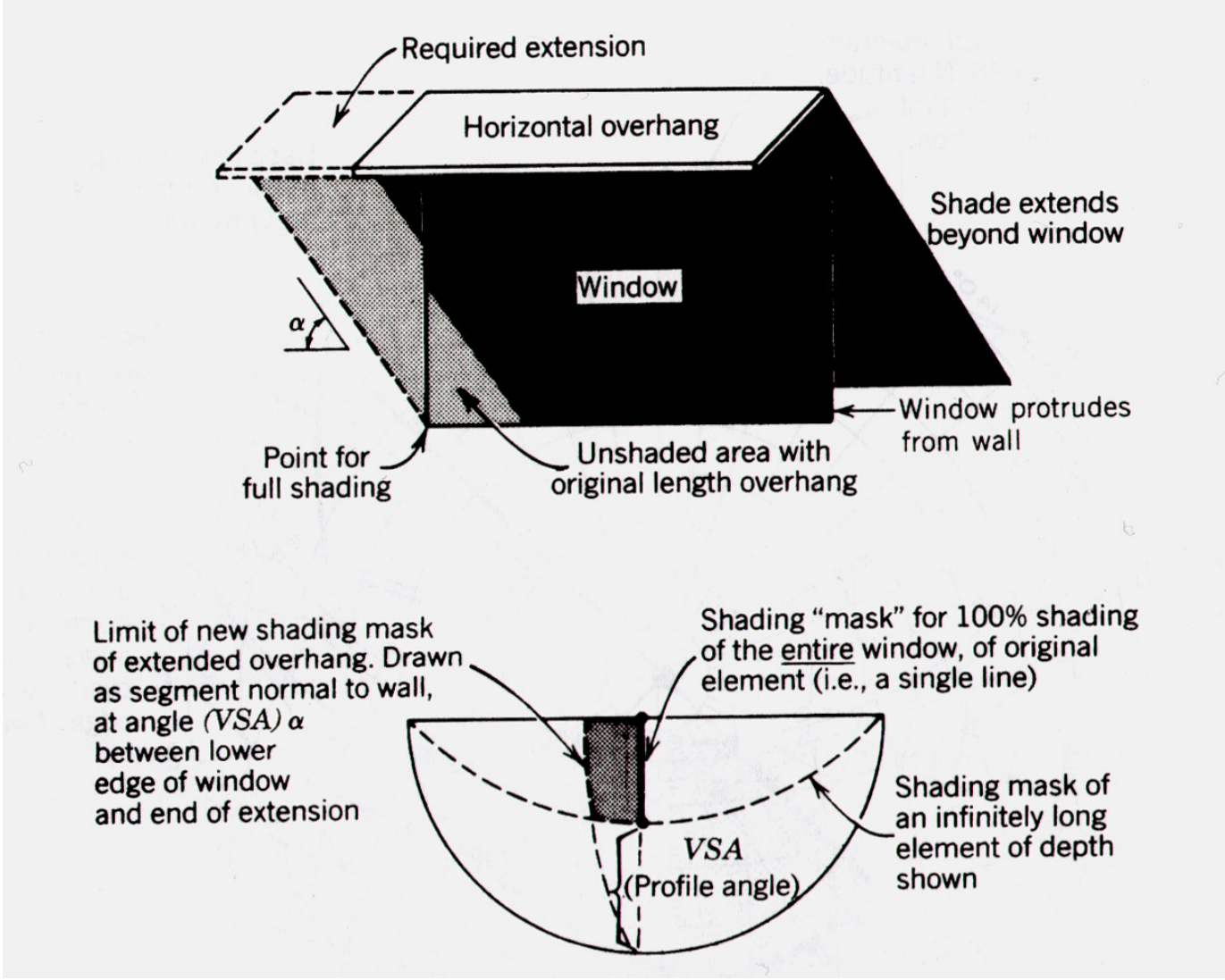
This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Mask & Their Uses



This week... Thermal Control | Solar Geometry and Shading Devices

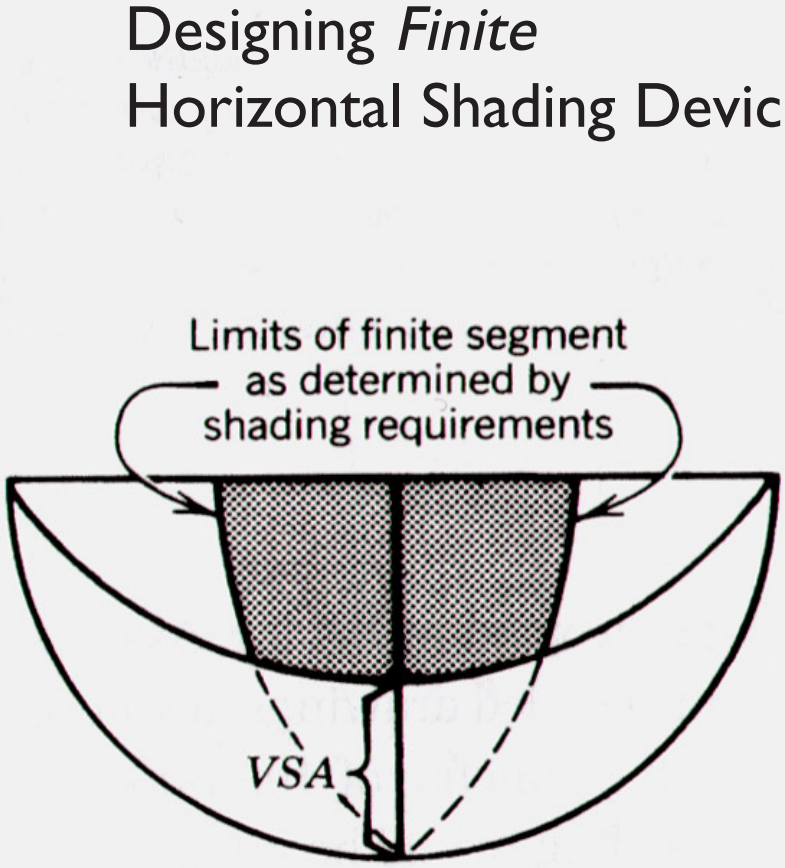
MEEB: The Sun and Its Position: Shading Mask & Their Uses

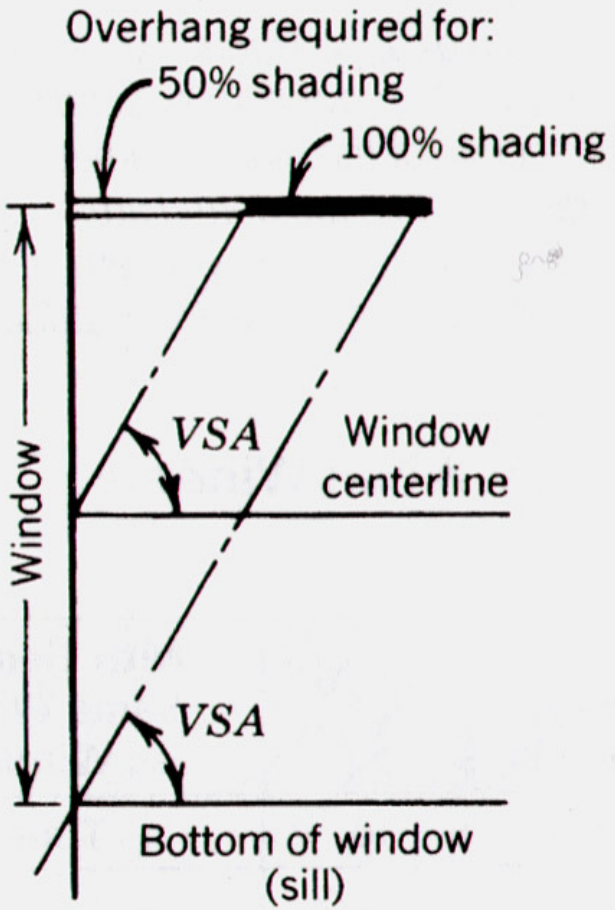


This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Mask & Their Uses

Designing *Finite*
Horizontal Shading Devices





This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Mask & Their Uses

Some qualitative conclusions:

> Shading can provide up to 100% coverage; deciding the desired coverage is the first design step.

> Shading depth is next decided upon, based in part on the desired coverage.

> An Overhang must extend *beyond* the sides of the window! "The amount of such an extension can be determined both graphically and analytically."

> Overhangs might be best designed asymetrically, depending on wall orientation.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Mask & Their Uses

Design Approaches:

> Initial Conceptual Sketches, including schematic section;
> Determine VSA for the initial design;
> Shading Mask based on VSA / Overlayed on Sunpath chart;

> ... Adjust geometry of shading device 'till desired effect is proved to be achieved.

This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Devices in Architecture







This week... Thermal Control | Solar Geometry and Shading Devices

MEEB: The Sun and Its Position: Shading Devices in Architecture

This week... Thermal Control | Solar Geometry and Shading Devices

Worksheet #5:
Solar Geometry and Shading Devices
(Chapter 6)

This week... Thermal Control | Solar Geometry and Shading Devices

Project #1: Design | Analysis | Design

For this design project, to be performed over the next month, you will be asked to design a small structure on the site illustrated below. Each week, you will be asked to document design choices which relate to the thermal behavior of the structure; you will be asked to analyze the factors which will influence that thermal behavior; and you will be asked to make additional design choices which might improve the energy-use performance of that structure. Each week will require a different technique or skill, each of which will be reflected in the textbook reading.

This week... Thermal Control | Solar Geometry and Shading Devices

Project #1: Design | Analysis | Design

The Site: 3418 Roland Avenue, Baltimore, MD 21211
N39°19'45" | W76°37'58"

ACAD2000 file @ http://www.jkargon-architect.com/94_Project01-EnvSystems.html
Go to "SitePlan" link, right-click, and choose "Save Target As..."

This week... Thermal Control | Solar Geometry and Shading Devices

Project #1: Design | Analysis | Design ***Schedule***

Today 20 Feb.	Project Data and Discussion;
Due for27 Feb.	Initial Structure Concept and Design; Initial Sun Shading Solutions, including shade device; Shading Mask for Shade Device.
Due for 5 March	Initial Material Design for Opaque Walls; Heat Flow Analysis for Opaque Walls.
Due for 12 March.	Initial Design Study of Transparent Elements; Heat Flow Analysis for Transparent Elements; Composite Envelope Heat Flow Analysis.
Due for 19 March.	Heating and Cooling Calculations; Solar Savings Fraction.

This week... Thermal Control | Solar Geometry and Shading Devices

Project #1: Design | Analysis | Design ***Suggestions***

> Look for examples and similar problems in **MEEB** and **Sun, Wind, and Light.**

> Design simply, with potential flexibility for introducing passive heating / cooling elements with subsequent iterations of your study.

> Don't sweat it!

This week... Thermal Control | Solar Geometry and Shading Devices

Project #1: Design | Analysis | Design ***Resources***

> Equidistant Sunpath Chart Template
[MEEB, Appendix D (p.1539)
Protractor

http://www.jkargon-architect.com/94_Project01-EnvSystems.html

> Some Fun Software: Solar Tool, http://squ1.com
Google Sketchup

Mega-Bigga

PBS Video Series: ***Design E²***

This week's showing: China: From Red to Green

This week... Cradle to Cradle: Chapter 5

Nature's "niche-filling" strategy:

A diversity of solutions to metabolize energy, the manifestation of which may change gradually or suddenly.

C+C's characterization of most human design responses:

One Size Fits All

C+C's principle in response to typical approaches to environment control:

Respect Diversity: Biodiversity... but also
Culture, Desire & Need...

This week... Cradle to Cradle: Chapter 5

A slight logical hiccup comes when one tries to draw C+C's analogies to nature too closely: How does a human ethical frame-work relate to an understanding of natural diversity; what might be overlooked without that ethical position?

The Fittest Survive, the Fitting-est Thrive

What might this mean to C+C?

What alternative interpretations might one possible draw?

This week... Cradle to Cradle: Chapter 5

All Sustainability is Local

> *Using Local Materials*

> *Connecting to Natural Energy Flows*

> *A Transition to Diverse and Renewing Energy Flows*

> *Reap the Wind*

This week... Cradle to Cradle: Chapter 5

A Diversity of Needs and Desires

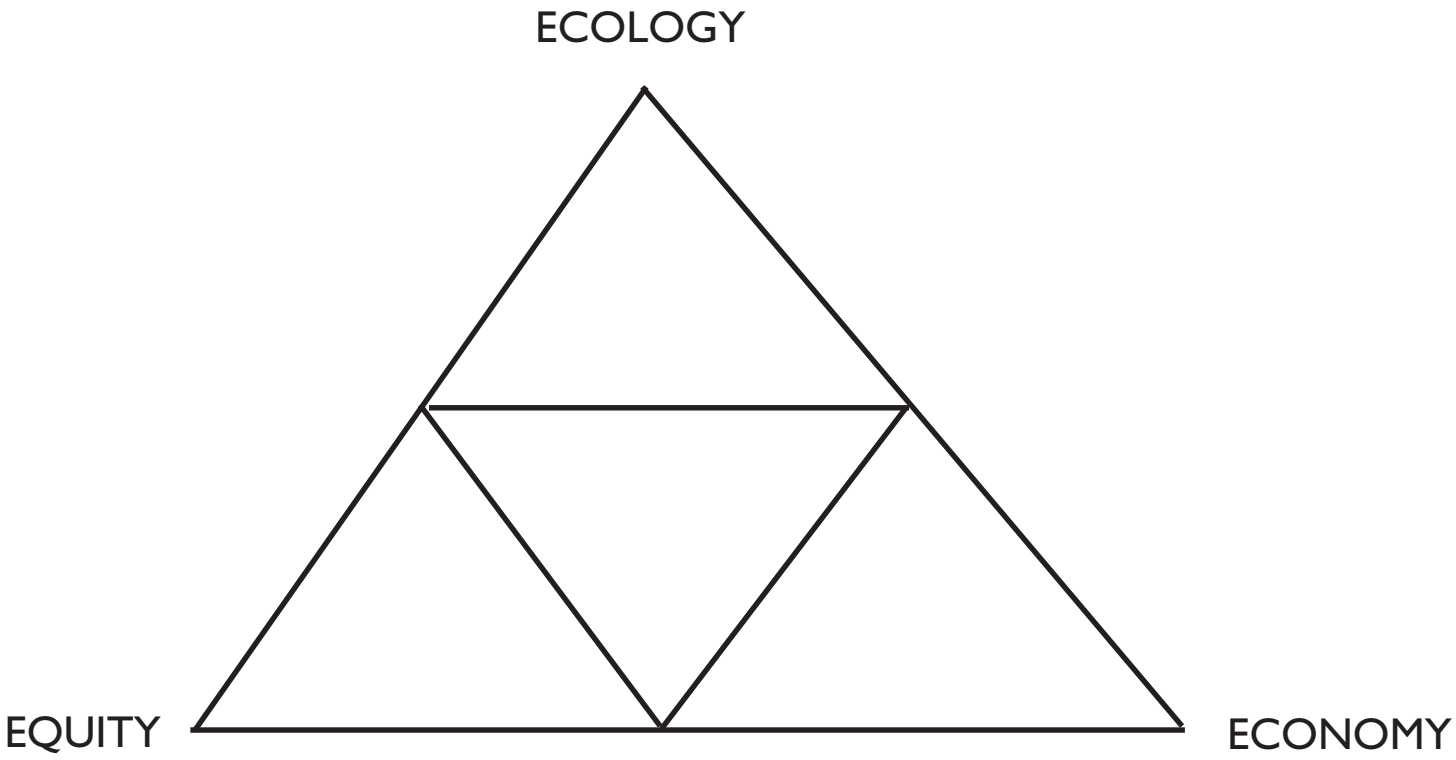
> *Form Follows Evolution*

> *A Tapestry of Information*

> *A Diversity of Isms*

This week... Cradle to Cradle: Chapter 5

Eco-Effectiveness (Fractal Diagram)



This week... Cradle to Cradle: Chapter 5

The Triple Top Line: Ecology, Equity, Ecology

> *An Industrial Re-Evolution*