

**Solar Geometry**

ARCH 331/431 Spring 2008  
Lecture 9

**announcements 4/29/08**

**Firm of the Month Presentation:**

**SRG Architects**

*Wednesday May 30, 12:30, ARCH 042*

**Assignment 4:**

Shading Model Studies

*Available Thursday; due in 2 weeks (week 7)*

**QUIZ 3:**

Thursday, 5/1



1. Today in Seattle, April 29, one month after the Spring Equinox, the sun rose

- A. North of East
- B. Due East
- C. South of East

2. Today in Seattle the sun will set:

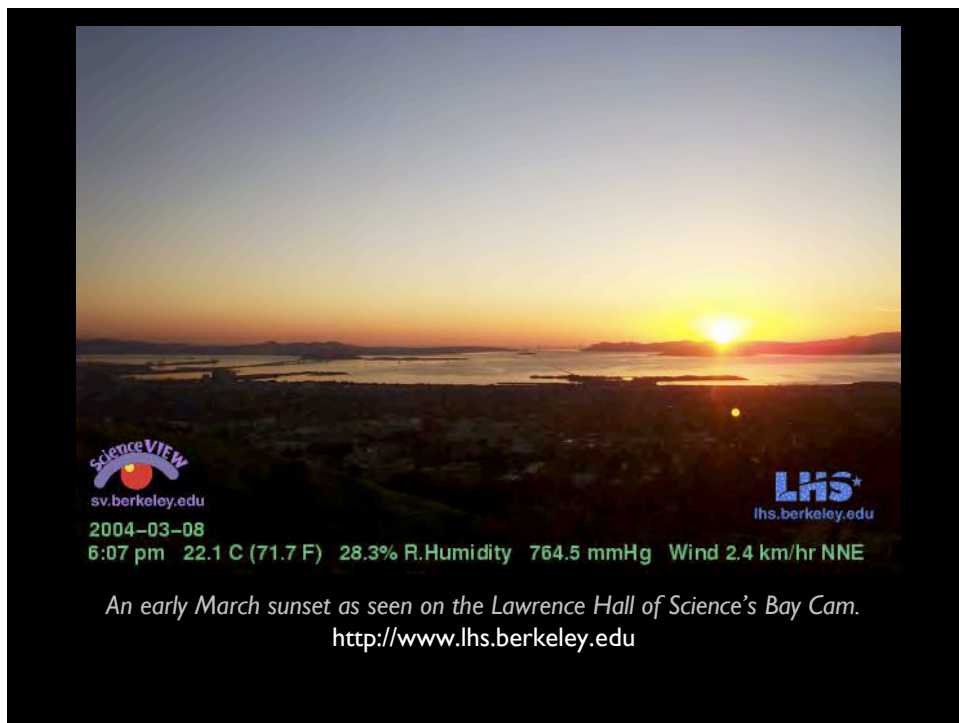
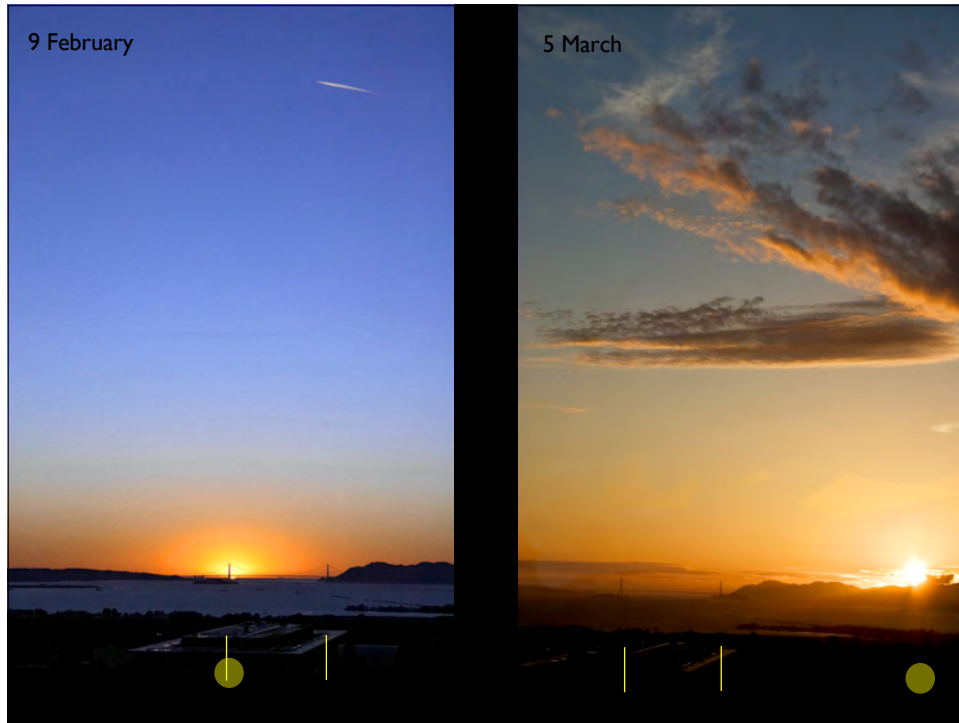
- A. North of West
- B. Due West
- C. South of West

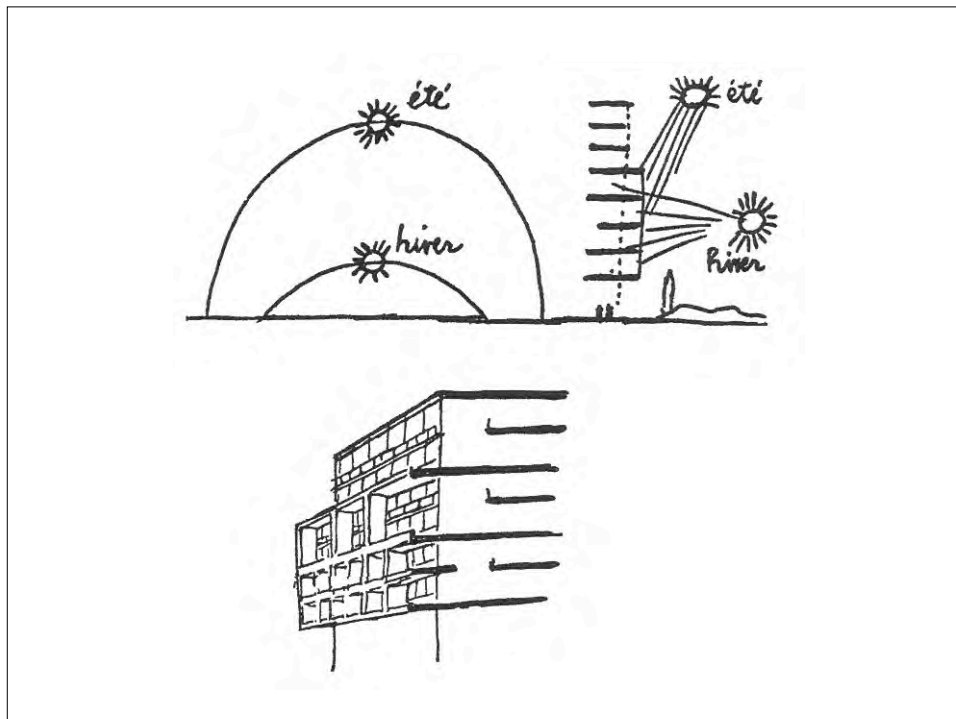
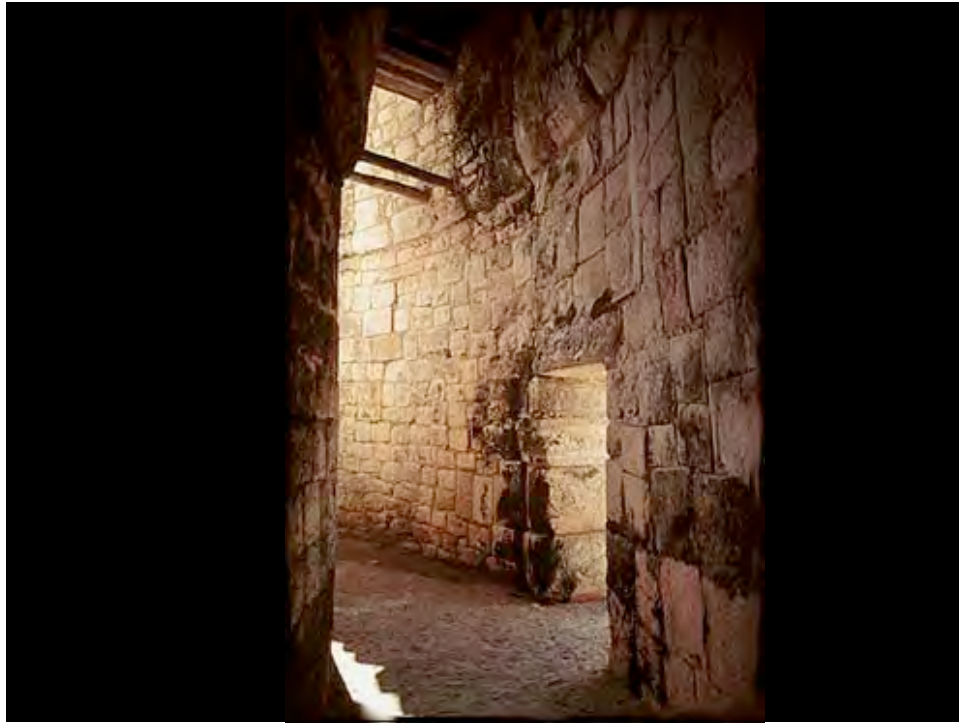
3. TRUE or FALSE:

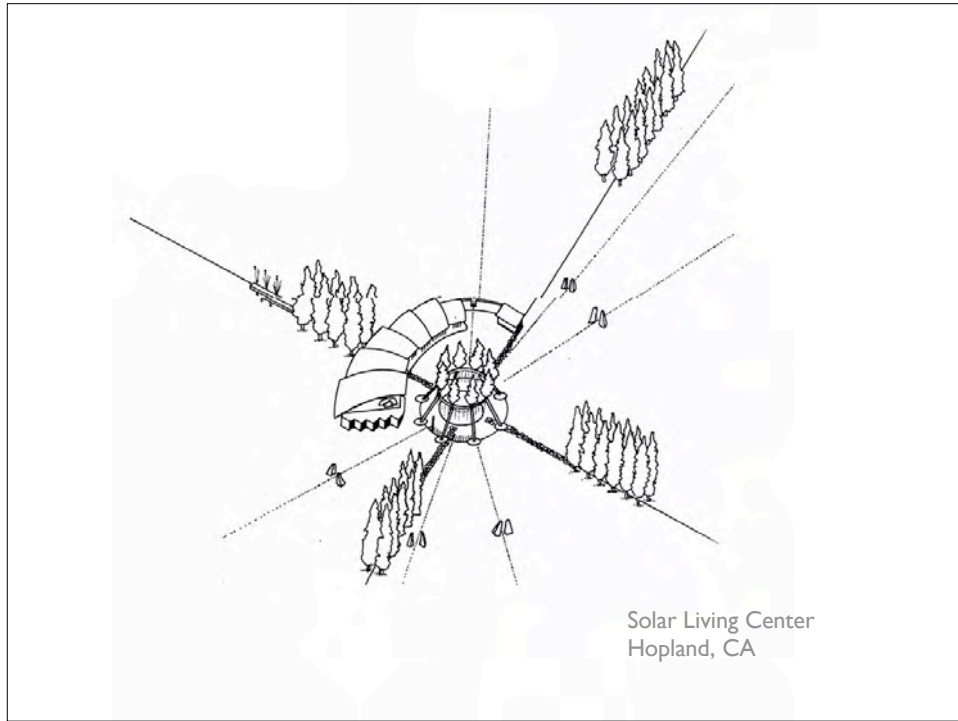
In Seattle (Latitude =  $48^\circ$ ), on June 21st, an un-shaded north-facing window receives nearly same amount of direct sunlight as a south-facing un-shaded window.

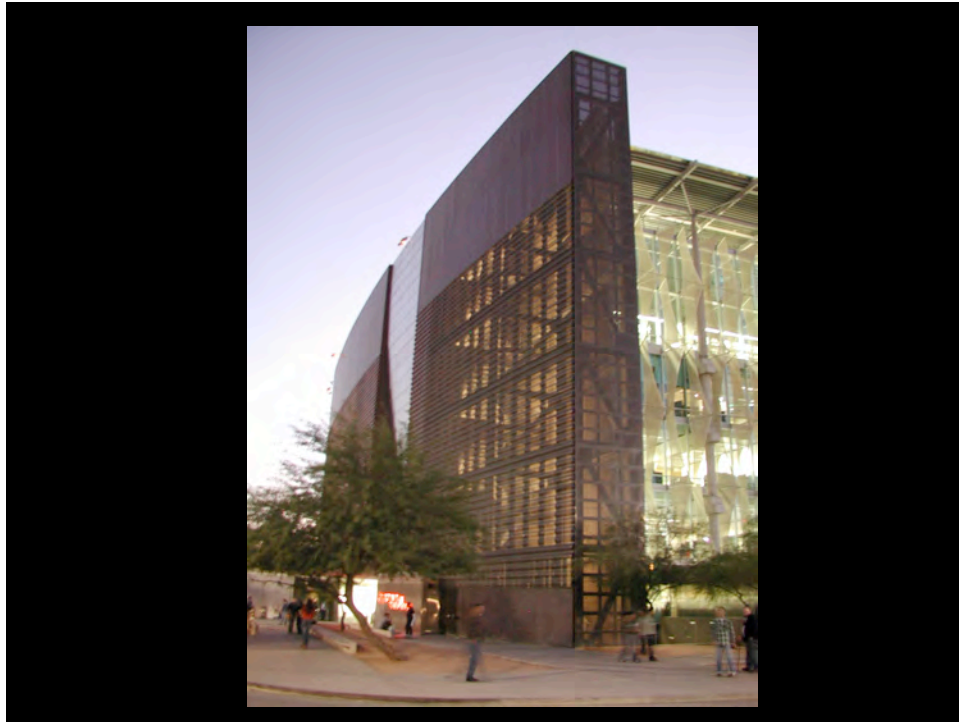
4. TRUE or FALSE:

The sun passes directly overhead (through the zenith) in Seattle at noon on June 21, the summer solstice.



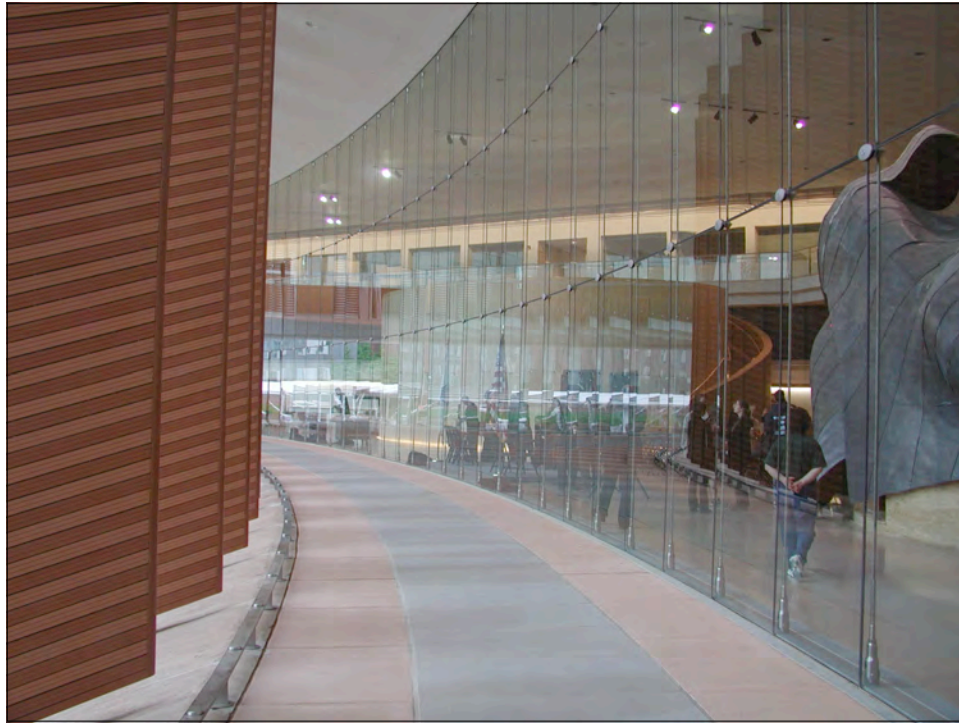


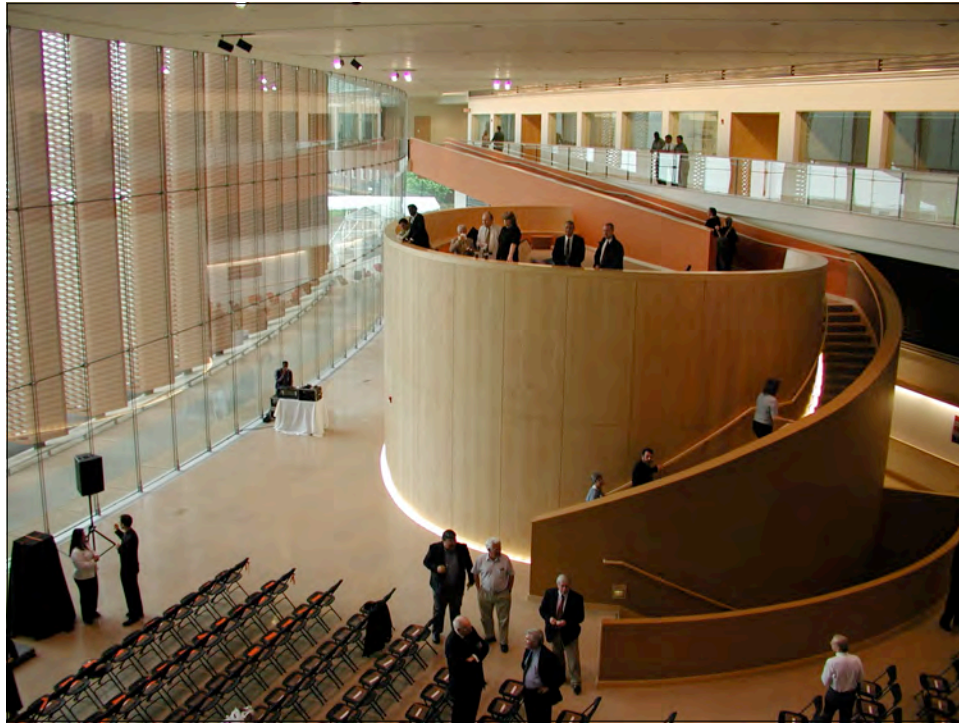










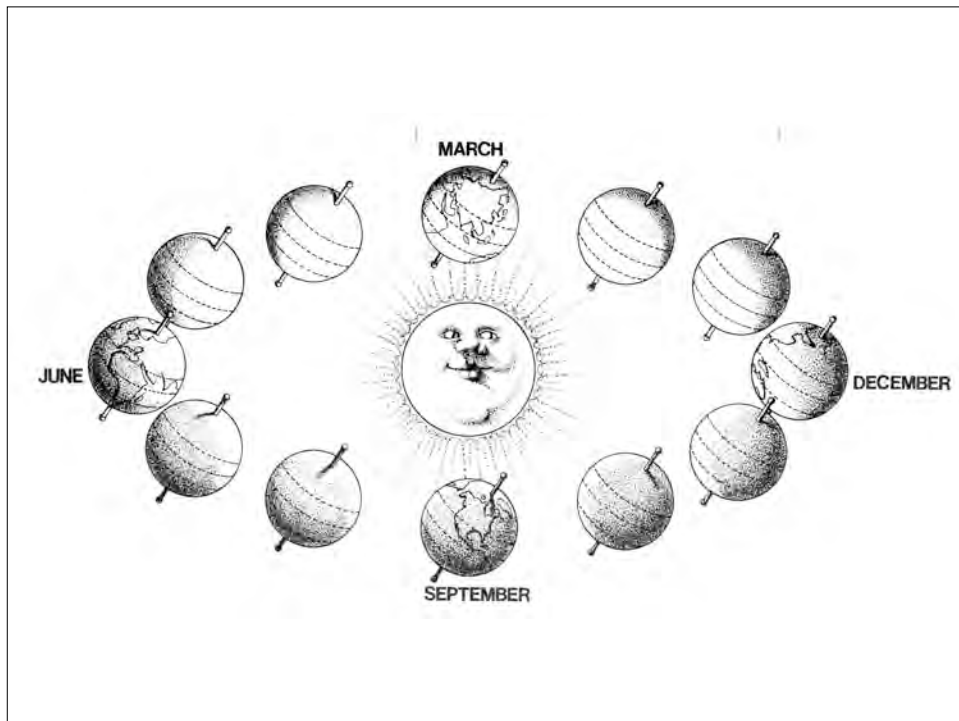
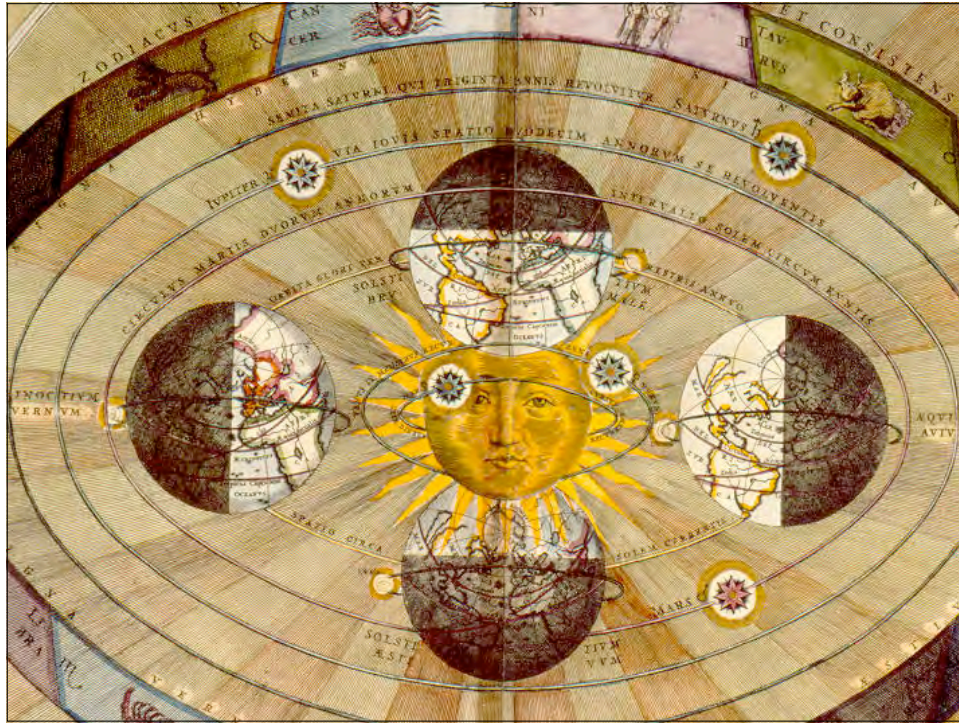


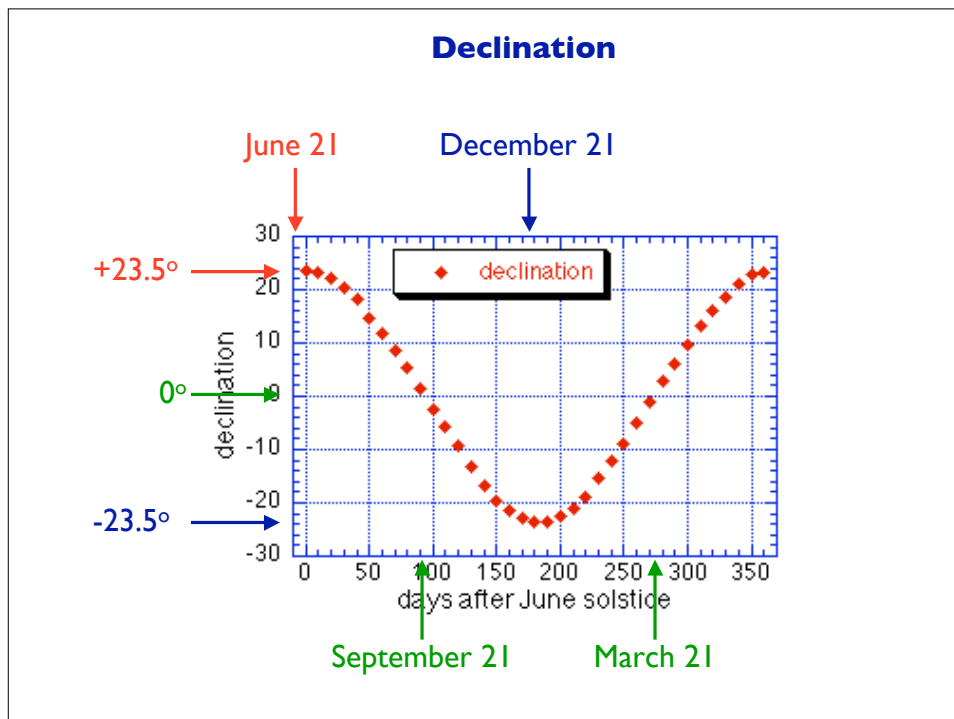
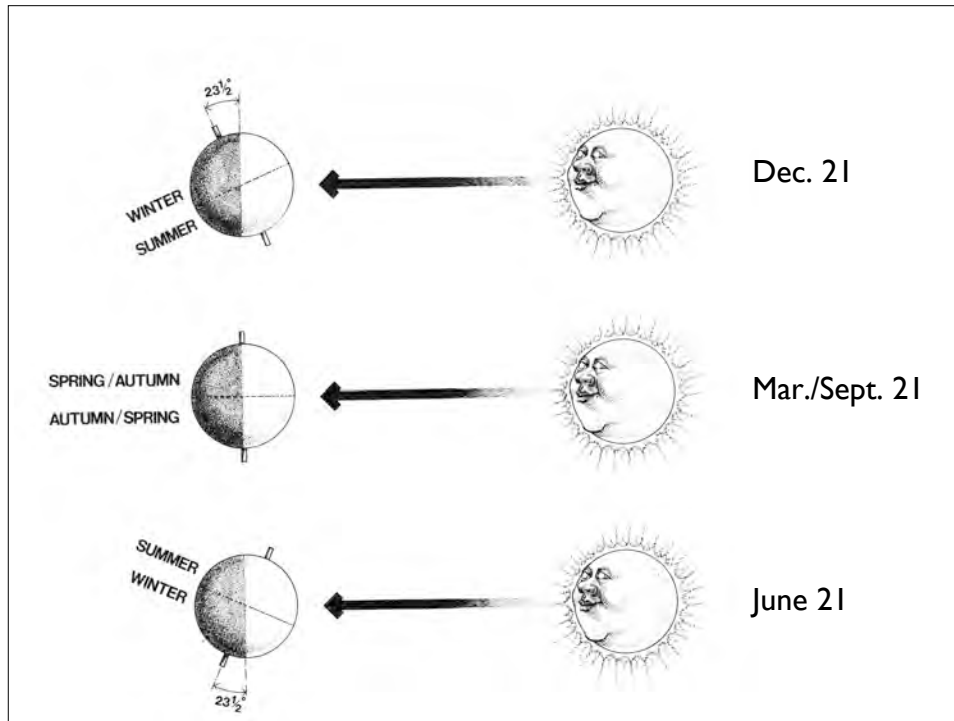




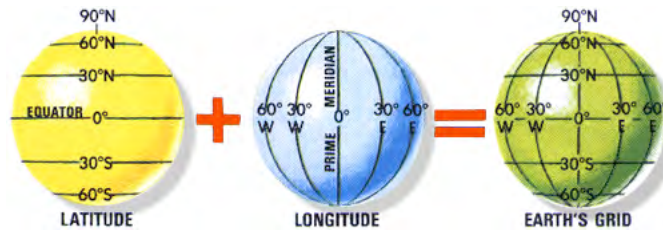
### Objectives of our study of Sun and Architecture:

- Where is the sun located at any time of the day and year?
- How much sun is entering my building at any time of day and year?
- How much sun or shade does my building *need* at any time of day and year?
- How do I match my building's need for sun with how much sun is available at any time of day or year?





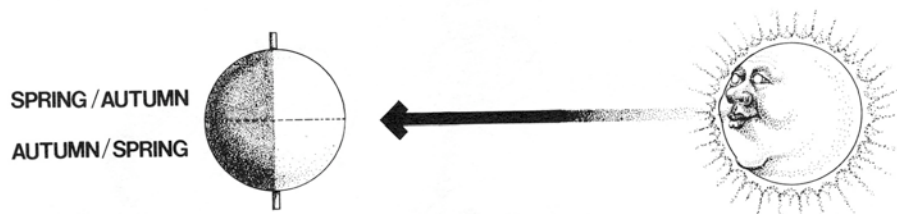
### Terminology for locating the sun

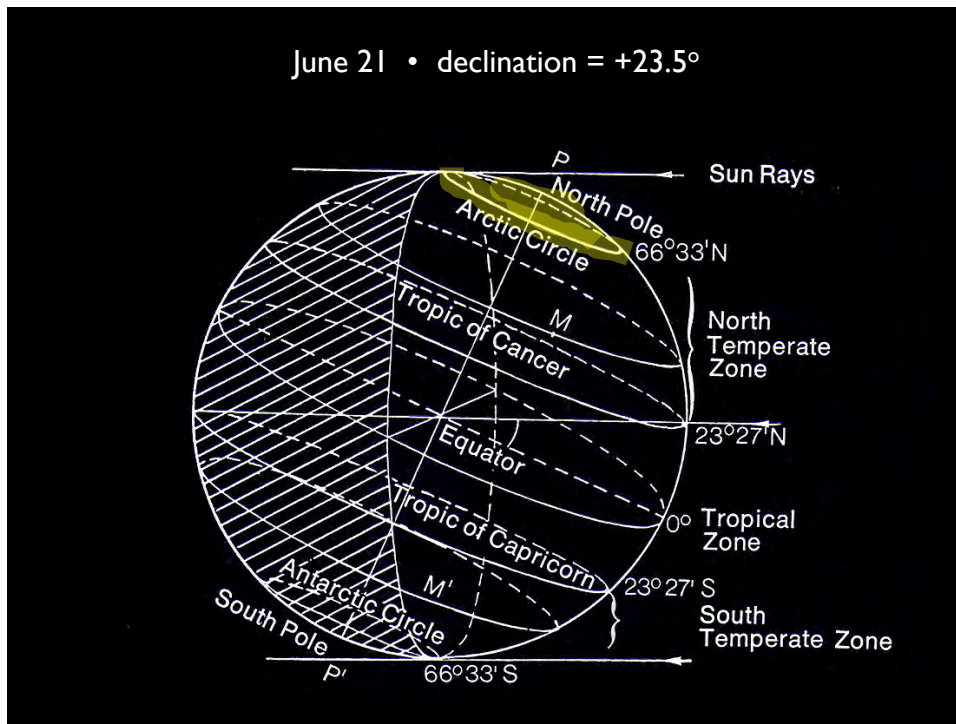


**Seattle: 47° 37' N 122° 20' W**  
 or 47.62° N or 122.33° W

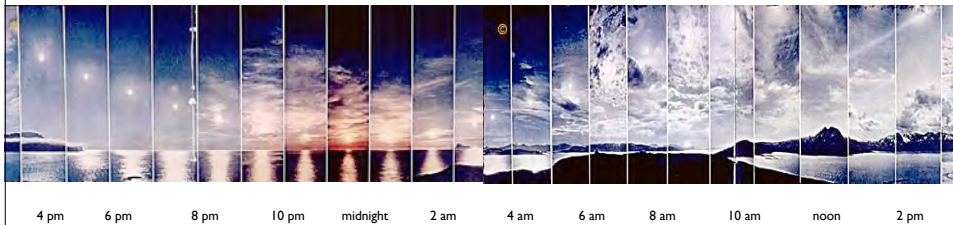
### Equinoxes: equal day and night

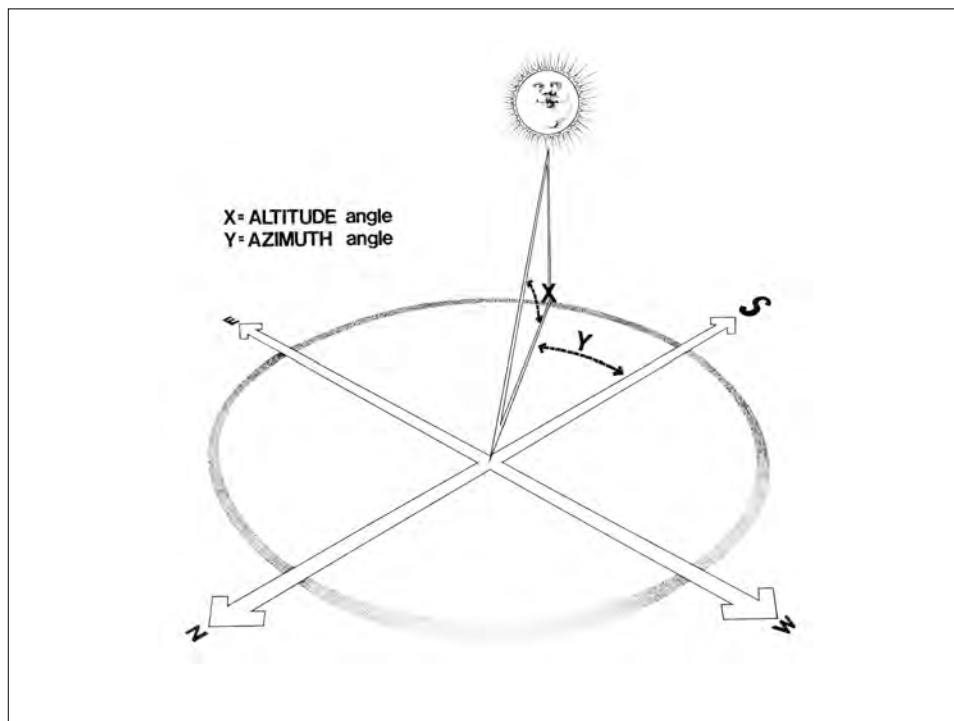
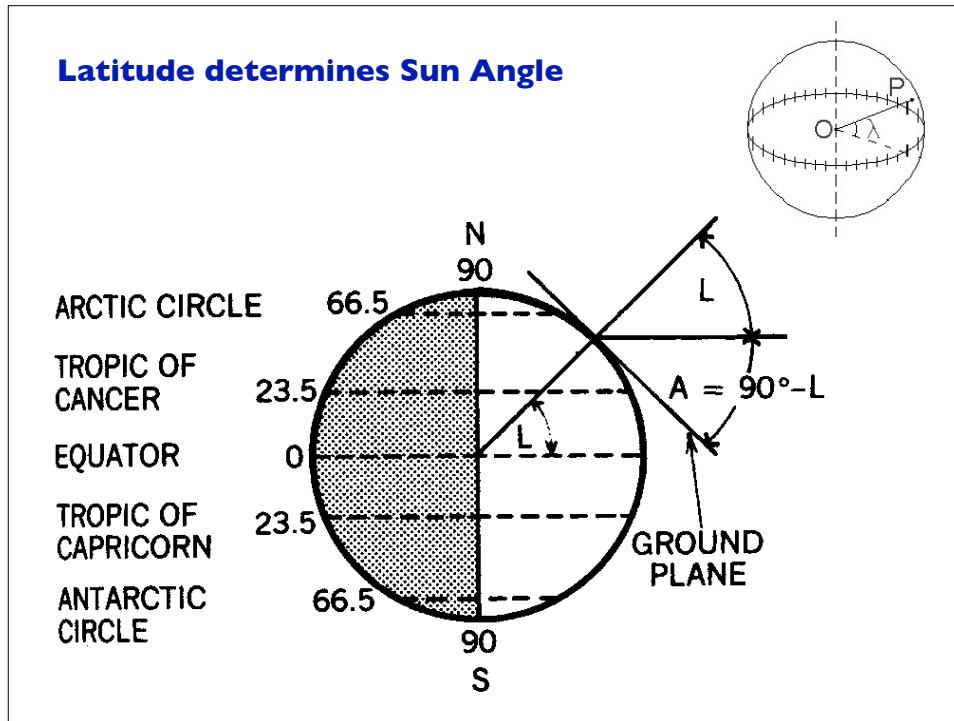
*March 21 and September 21*





Summer above the arctic circle in photographs





### Sun's **Altitude** Angle at Solar Noon:

$$\text{Altitude} = 90^\circ - \text{Latitude} + \text{Declination}$$

Latitude            ~48°

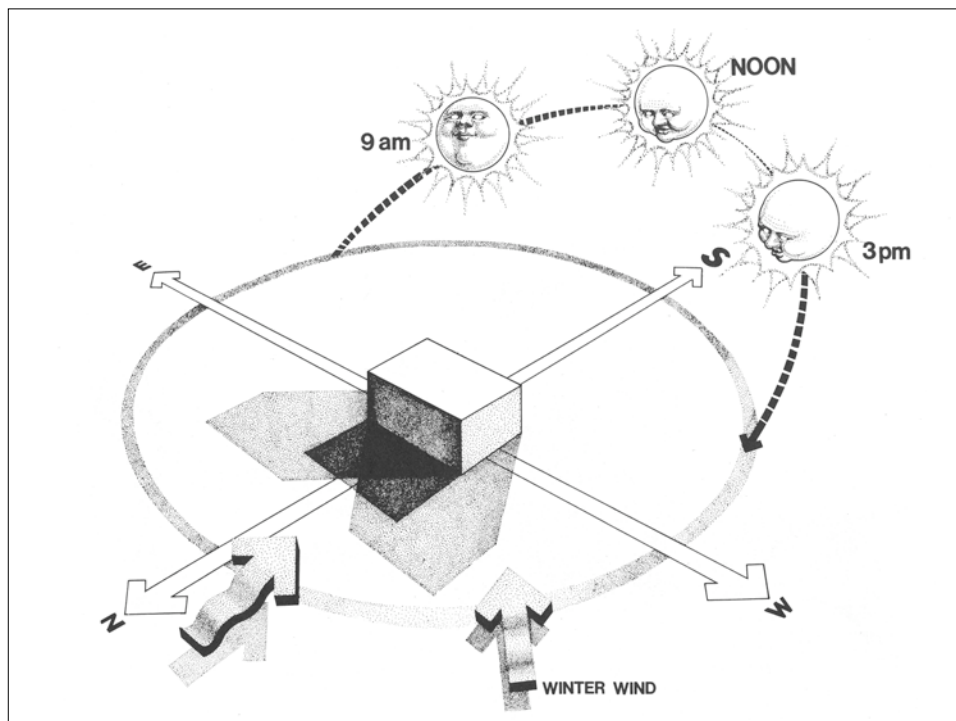
Declination:	December 21	=	-23.5°
	March/April 21	=	0°
	June 21	=	+23.5°

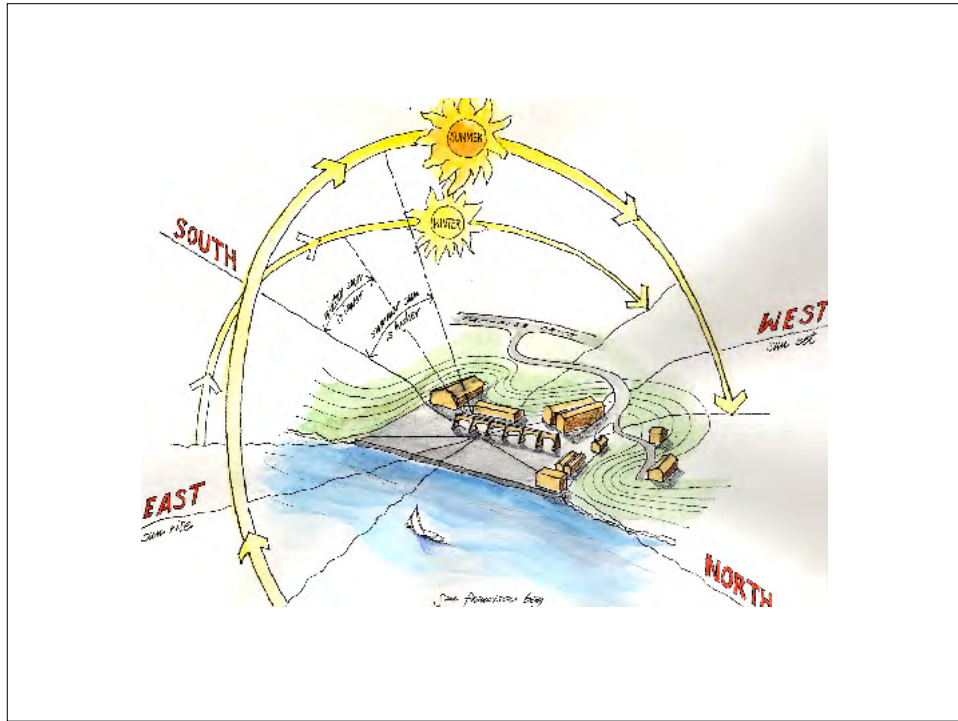
#### **Altitude Angle at Solar Noon in Seattle:**

**Dec. 21:**             $90^\circ - 48^\circ - 23.5^\circ = 18.5^\circ$

**Sept./Mar. 21:**  $90^\circ - 48^\circ + 0^\circ = 42^\circ$

**June 21:**             $90^\circ - 48^\circ + 23.5^\circ = 65.5^\circ$





**Keeping Time:**

Sun Dials and Sun Markers



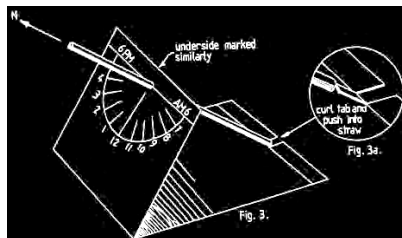
### Equatorial Sundial

- Simple: easy to construct
- Easy to adjust for latitude
- Gnomon is parallel with the equator
- Can tell both time of day and time of year



### Equatorial Sundial

The equatorial or universal sundial is the easiest dial to make. The gnomon is parallel to the earth's axis and the dial plate lies in the plane of the equator. The hour lines are spaced at  $15^\circ$ , so that the face looks very much like that of a traditional clock except .....



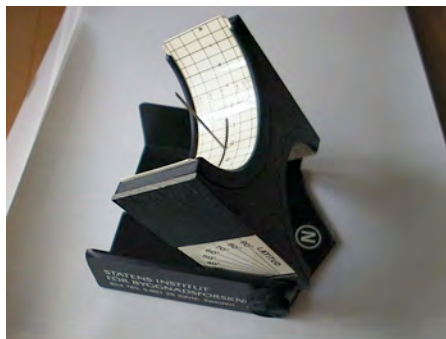
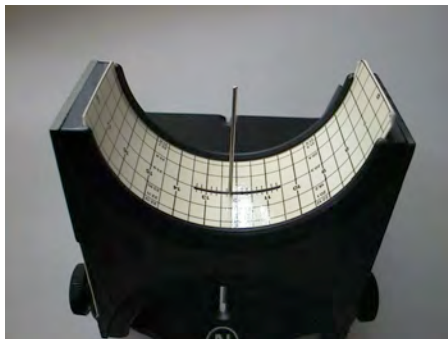
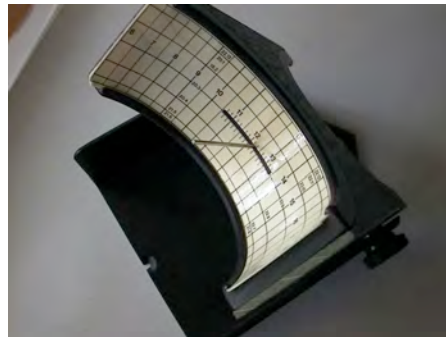
Equatorial Sundial for 44° N. Lat.

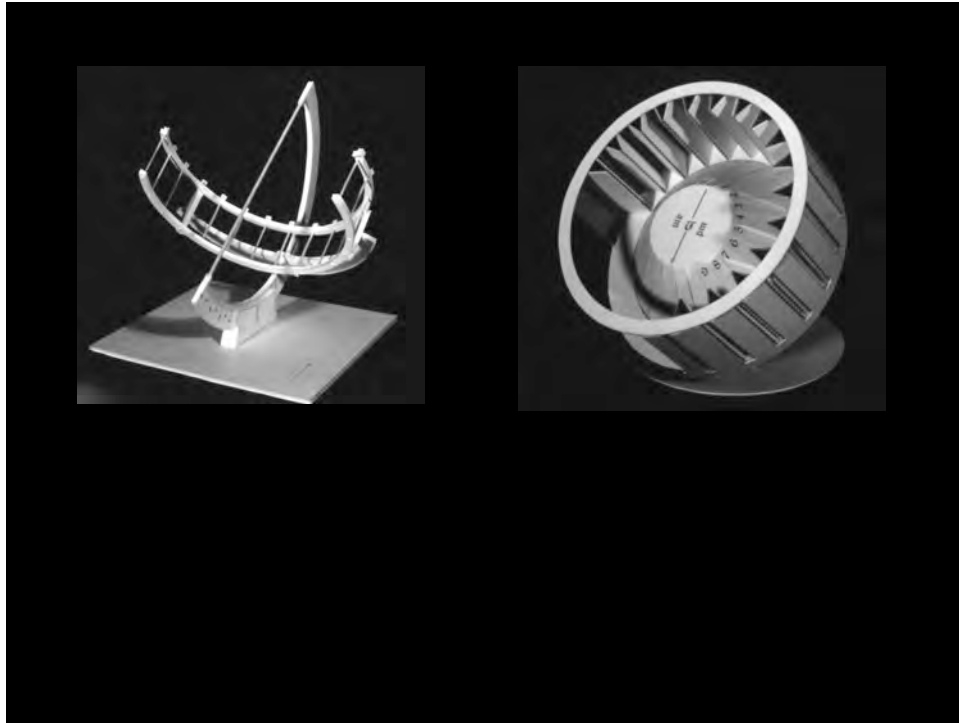
The style in an equatorial sundial is tilted at an angle equal to the latitude, the high end of the style points north, and the disc is parallel to the earth's equatorial plane.

A contemporary dial near the equator -- Hong Kong University of Science and Technology

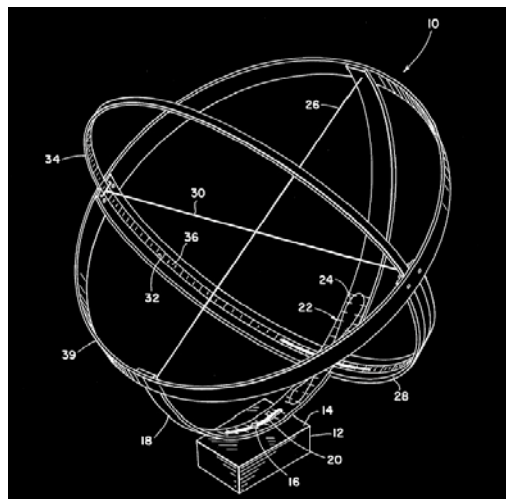
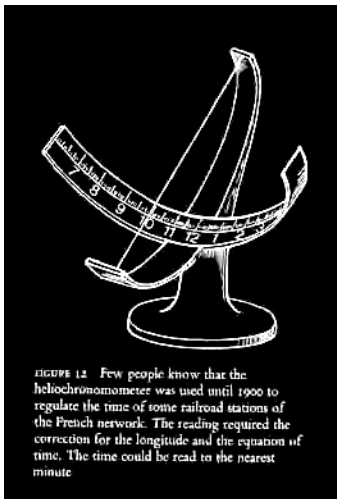


This small equatorial dial made for shading models has an adjustable hour scale





And then there is the issue of precision in timekeeping



$\phi$  is the Latitude angle for the location where the sundial will be used

the Style for the afternoon hours

the Style for the morning hours

A - the Gnomon

C - the Solar Noon lines

the Hour Numbers

B - the Dial Plate

D - the Hour Lines

Toe of the Gnomon

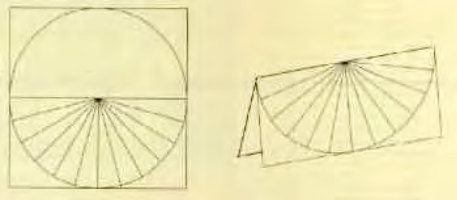
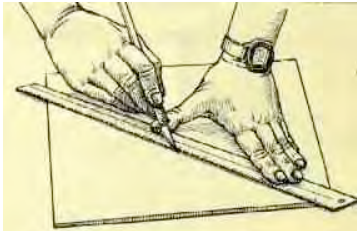
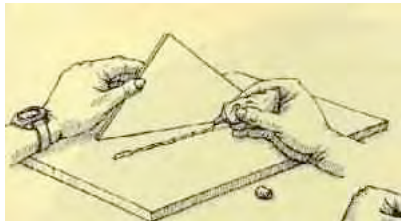
Origin of time divisions for the morning side of the sundial

Origin of time divisions for the afternoon side of the sundial

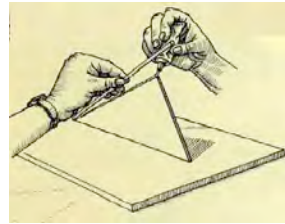
*Fig. 2. Parts of a sundial. In this example, the outer edge of the gnomon shadow tells us that the solar time is 9 o'clock in the morning. Notice that the shadow starts from the base of the gnomon, and has the same shape as the gnomon, but it is distorted due to its projection onto a different surface.*

## Horizontal Sundial

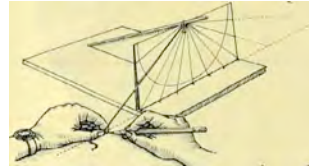
### A horizontal sundial in 6 easy steps:

1. Make a protractor by dividing a half circle with lines at an even  $15^\circ$  spacing. 
2. Create a style from a right-angled sheet of stock. Cut at an angle that equals latitude for the sundial site. 
3. Glue the style to the north – south axis of the sundial's base. 

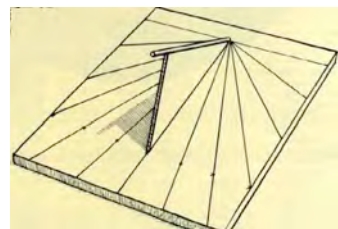
- Slice a tube on its long axis and affix to the top of your style.

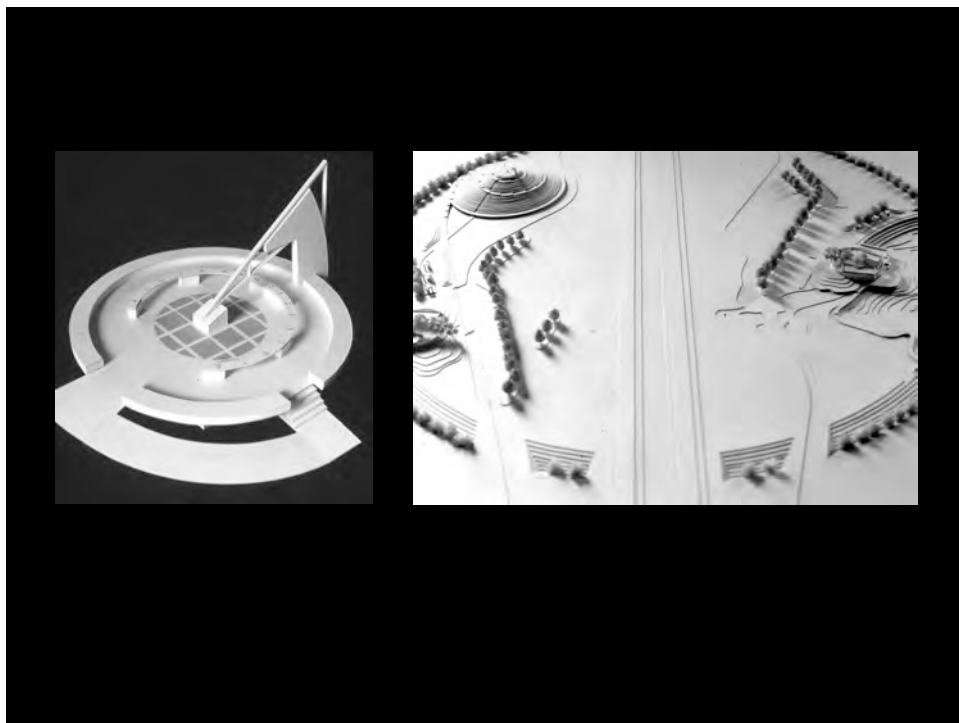


- Lean your protractor against the north slope of your style and project the angles to the sundial baseplane using a string.

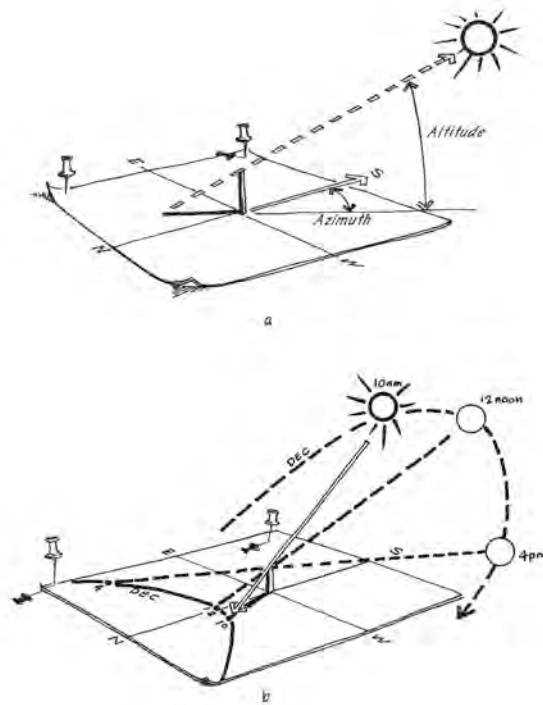


- Connect the south base of the style to your projected points with straight lines.





**Sun Peg Charts**



**Sun Peg Chart**

Appendix D, MEEB 10th, pgs. 1535-1538

