

assigned April 5, 2006

due April 12, 2006

## HOMEWORK #5

### Designing with Natural Light – Visual comfort

#### Questions

- a. For a museum, what are the critical issues of using zenithal natural light for a museum ? and of using artificial light ?
  
- b. What is the least adequate orientation for this façade equipped with fixed vertical solar protection devices, if the building is situated at our latitude?
  
  
  
  
  
  
  
  
  
  
- c. If you were to define the ideal window system on a South oriented façade in Boston for an office space that is 10 meter deep, what would be your 5 major criteria ? same question for a North-oriented façade.

#### Problems

1. The individual reading spaces of the Phillips Exeter Academy Library (Exeter, NH, designed by Louis Kahn in 1967-1970), are positioned along the periphery of the building, and are separated from the large central atrium by the rows of book shelves. In addition to the diffuse light brought in by the large superior windows, each reading cell benefits from direct sunlight through a small lateral window positioned at desk height and equipped with a sliding wood blind. All four façades have been treated equally as far as solar protections are concerned.

Direct sunlight should be avoided on the work space at anytime.

On the plane and section views of individual reading cells given on the next page, determine the limit angles  $\alpha_1$ ,  $\alpha_2$  and  $\beta_1$  for solar penetration and report the angles on a tracing paper over the given shadow protractor, by shading the areas corresponding to sun directions for which the lower windows always benefit from total protection.

Upper and lower windows pointed out on façade

Individual reading cells

Axonometric view

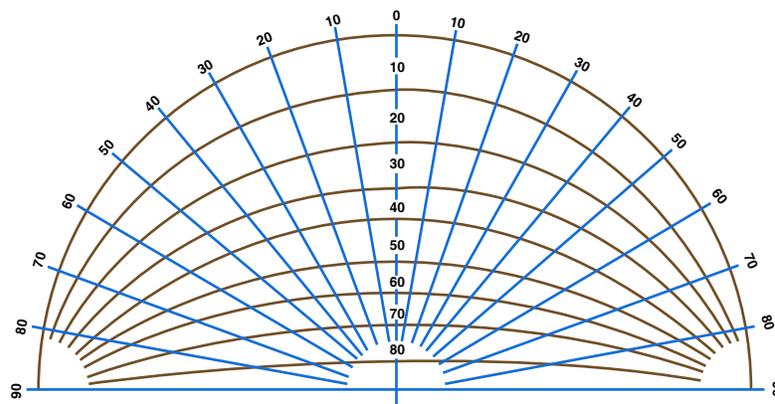
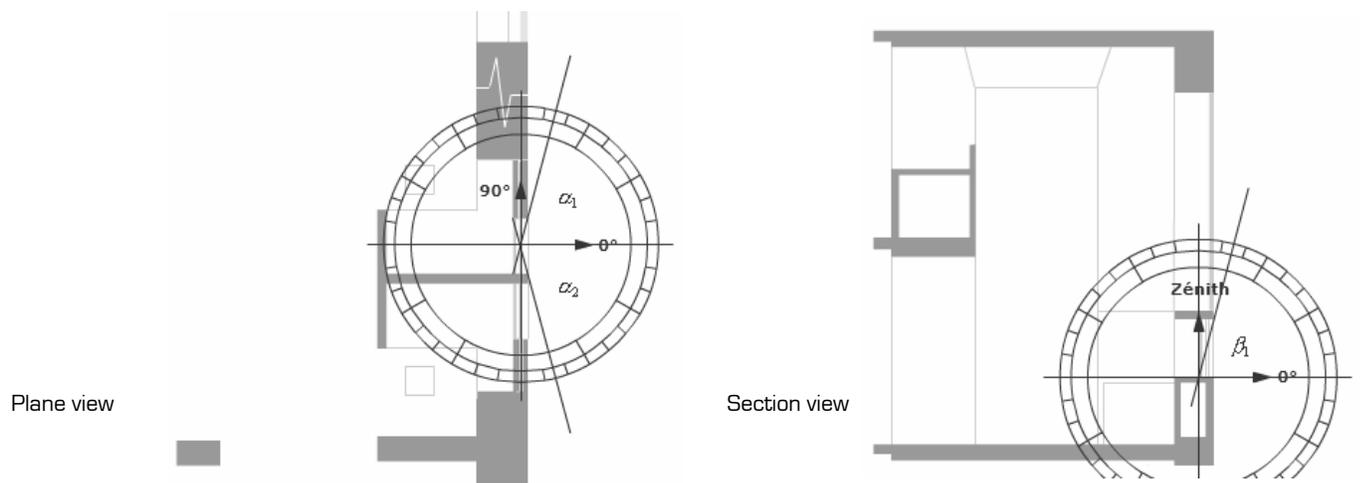


Image by MIT OCW.

Superpose the projected shadows on the stereographical view given on the next page, which corresponds to the latitude  $42^{\circ}22'N$  of Exeter for the four façade orientations. Analyze the solar penetration occurrences over the year for each façade orientation.

What are the critical issues of choosing to have no solar protection for the upper windows?

What are the critical issues of having sliding wooden blinds for the lower windows as sole shading system?

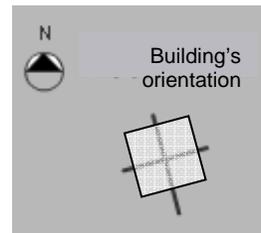
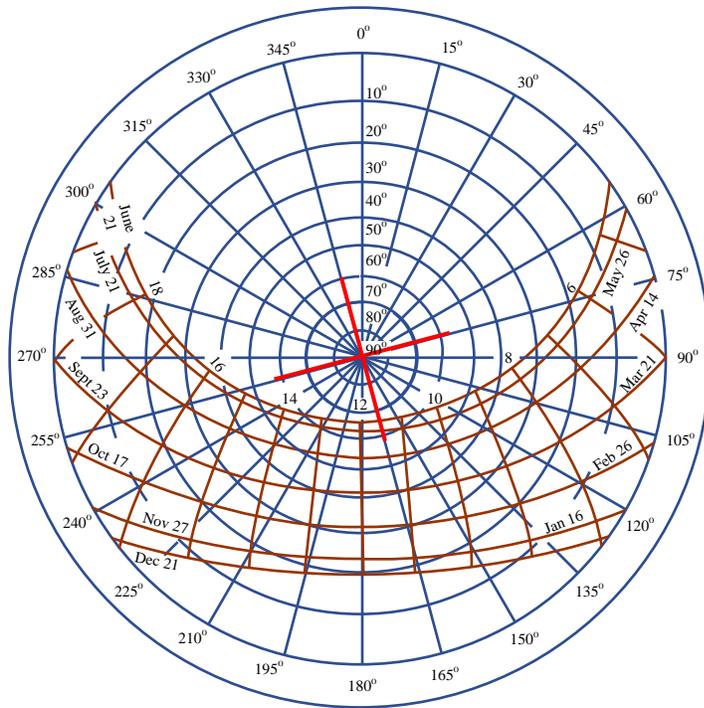


Image by MIT OCW.

2. Consider the window whose section view is given here. It belongs to a South oriented façade of a building situated at 48°N.

How would you dimension a fixed horizontal solar protection in order that at noon solar time, the whole window is in the shadow between May 21 and July 21 (around the summer solstice where solar gains are to be avoided) whereas no shadow should occur between November 21 and January 21 (winter solstice where solar gains are desired) ?

Use the fact that both on January 21 and November 21, the sun's apparent elevation  $\eta$  is 22.2°, while it is of 62° on May 21 and July 21.

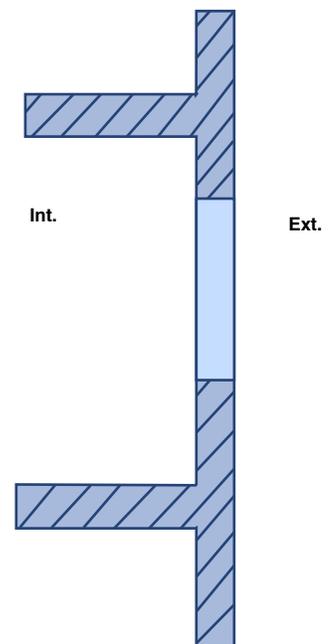


Image by MIT OCW.

Reading assignment from Textbook

"Introduction to Architectural Science" by Szokolay: § 2.2 to 2.4

Additional readings relevant to lecture topics:

"How Buildings Work" by Allen: Chap 13

"Heating Cooling Lighting" by Lechner: Chap 9 + Chaps 12-13

## Design project:

### Instructions for the next report (Lighting diagnostic portion of it)

Choose a space within your building where the contribution of daylight to the inside illumination is preponderant. Basically, what your diagnostic should provide is a conclusion on whether the lighting, and especially daylighting, conditions are acceptable, good, excellent or poor and why.

More specifically, supporting your analysis with pictures and drawings, and, if you think it would be beneficial, using the manual heliodon presented in class<sup>1</sup> (picture below) with a rough model of the space, summarize and illustrate:

- the moments of the year where sunlight penetration is expected, based on the orientation of the openings and the masking of the surrounding buildings / natural obstacles,; specify the portions of the space that will be sunlit
- the types of openings, the types of glazing, the types of shading system and the performances of their combination as far as glare and contrast prevention as well as heat gains and losses issues are concerned; always specify the portions of the space where your analysis is applicable
- what delimits the portions of the space mainly relying on daylighting from those essentially or only relying on electric lighting and to what extent the scission between the two is recognizable
- how reflection on inside walls is used to illuminate the space and what kind of surfaces we have on the floor, side walls, ceiling

## Portable Heliodon

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<sup>1</sup> Coordinate with Jeff Anderson for borrowing it.