Columbia University
School of Architecture, Planning and Preservation
Spring 2013

A 4635 : DAYLIGHTING

"Natural light is the only light that makes architecture Architecture…"
- Louis Kahn

Time: Fridays, 1100h-1300h
Room: Ware Lounge (verify)
Instructor: Davidson Norris, Principal - Davidson Norris, Architect & Carpenter Norris Consulting
T: 212 431 6821 / email: dn192@columbia.edu

Description:

This course will focus on the daylight as a prime generator and articulator of architectural space. We will start with the key relationship of light to the eye and its perception. Then we will shift to the primary relationship of the sun to the building over time. From there we will investigate the basic means by which daylight interacts with both the environment and the building. Then we will focus on the architectural control of daylight – shading. We will then move on to various perimeter (ex: lightshelves) and core strategies (ex: atria) that can provide daylight to the interior and drive it deeper. We will then discuss various advanced daylighting systems and technologies.

While this is primarily a technical course, it explores daylighting technology and strategies as they apply to the articulation of architectural space. So at its heart are matters of poetry and aesthetics. To this end students will deliver a final daylighting project where they will design a light articulating space of their own choosing and then use a daylighting model to show its interactions of light and space.

Regarding technical daylighting, students will develop a working knowledge of the Sun Angle Calculator, used for solar angle calculations and the design of shading devices, as well as a familiarity with the BRE Pepperpot Overlay, used for the calculation of illuminance in simple spaces. Both are graphical techniques.

There is no textbook. I will hand out class outlines at each class. Key daylighting references will be on the reserve shelf at the library. Instruction will be take the form of lectures. Homework assignments will be graded. There are no tests or exams but the final graded daylighting model will be a key measure of semester performance. Each student will purchase a Pilkington Sun Angle Calculator. To obtain:

http://www.pilkington.com/the+americas/usa/english/building+products/tools+and+calculators/sun+angle+calculator.htm

Class Assignments:

1. Development and presentation of case studies highlighting daylighting design.
2. Hand calculation of fundamental solar angles.
3. Determination of shading using Sun Angle Calculator
4. Determination of daylight quantities using pepper pop method.
5. Development and photographic presentation of daylighting study model(s).

Schedule:

01.25 **1. Daylighting Design: Introduction**

- Course introduction and description
- Case study: Ronchamps

Assignment: case study. Select a building and present a written and visual description of its daylighting intent and design solutions.

02.01 **2. Why Daylighting?**

- Daylight and health
- Daylight and economics
- Daylight and productivity

Assignment: case study. See above

02.08 **3. Sun and Earth: the Photonic Ride**

- Sun as a daylight source
- The visible spectrum
- Photon interactions with the atmosphere
- Photon interactions with objects.

Assignment: Proposal for a daylighting space/device that explores a light in nature phenomenon

02.15 **4. Daylight and the Eye/Architecture**

- Daylight and the eye
- Daylight metrics (luminous flux, illuminance and luminance)
- Daylight and visual comfort (glare)
- Daylight sources for architecture
- Daylight resources (sky and solar illuminance values)

Assignment: using latitude, altitude, solar surface azimuth and IES solar charts, determine the illuminance on an east-facing window for 3 different latitudes at 10 am.

02.22 5. **Sun and Earth: the Cosmic Dance**

- The diurnal cycle
- The seasonal cycle
- Solar altitude, azimuth and time
- Daylight availability

Assignment: calculate apparent solar time for June 15th at 1500h DST at lat 40° N and corresponding solar altitude and azimuth.

03.01 **6. The Sun Angle Calculator**

- Sun angle calculator (SAC) introduction
- Profile angle and solar surface azimuth
- SAC to determine solar azimuth, altitude and profile angle.
- Solar mapping explanation/demonstration.

Assignment: using SAC map room interior and determine at what times sun will reach the target point.

03.08 **7. Daylight and Exterior Shading**

- Introduction to shading.
- Fixed shading devices (overhang, fin and eggcrate)
- Operable shading devices

Assignment: using SAC, determine window and roof shading devices necessary to obstruct sunlight at target point.

03.15 **8. Daylight and Site**

- Building-to-obstacle shading and angle of acceptance
- Aperture shading
- Shadow projection
- Building as reflector

Assignment: using SAC develop south facing reflector for north facing window.

03.22 **9. Break**

03.29 **10. Daylight on the Worksurface 1**

- IES recommended illuminance levels
- Rules of thumb
- Daylight factor
- Average daylight factor
- Daylight factor overlay (pepper pot diagram)

Assignment: using pepper pot diagram determine daylight factor for model room developed in assignment 5.

04.05 **11. Daylight on the Worksurface 2**

- BRE Daylight Protractor to determine daylight factor
- How to determine sky component, exterior reflected component, interior reflected component

Assignment: using BRE protractors determine daylight factor and illuminance for simple room

04.12 **12. Sidelighting**

- Illuminance profile
- Ground and internal reflectance
- Ceiling height and shape
- Overhangs and light shelves
- Light guides

Assignment: daylight model. Using sundial, student will model and present a daylighted physical space of their choosing under real sun at winter and summer solstices and equinox.

04.19 **13. Sky and Atrium Lighting**

- Skylight form
- Skylight throat and reflectors
- Skylight baffles and shades
- Roof monitors and reflectors
- Atrium form and proportions
- Atrium finishes and skylight structure

Assignment: daylight model. See above.

04.26 **14. Advanced Daylighting Systems**

- Glazings
- Light shelves
- Light guides

Assignment: daylight model. See above.

05.03 15. **No class**

05.10 16. **Final review**

Assignment: presentation of final daylight model