Columbia University
School of Architecture, Planning and Preservation
Spring 2015

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
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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.

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 Mask
4. Determination of daylight quantities using pepper pop method.
5. Development and photographic presentation of daylighting study model(s).

Schedule:

01.23 **1. <u>Daylighting Design: Introduction</u>**

- Course introduction and description
- Case studies: an historical review of important daylighted structures

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

01.30 **2. <u>Why Daylighting?</u>**

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

Assignment: case study. See above

02.06 **3. <u>Sun and Earth: the Photonic Ride</u>**

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

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

02.13 **4. <u>Daylight and the Eye/Architecture</u>**

- Daylight and the eye
- Daylight metrics (luminous flux, illuminance and luminance)
- Daylight and visual comfort (glare)

Assignment: Determine the illuminance on an east-facing window for 3 different latitudes at 10 am.

02.20 5. **<u>The Daylight Factor (DF) calculation - introduction</u>**

- Daylight factor
- Sun/earth astronomy/geometry
- Solar time vs standard time
- Solar altitude, azimuth
- Sun angle calculator - introduction
- Sky types and illuminance
- Daylight factor on external surface

Assignment: use the pepperpot overlay on the sun angle calculator to determine the Daylight Factor on the exterior of a NYC shaded midrise façade.

02.27 **6. <u>The DF calculation - sidelighting</u>**

- Required illuminance
- Solar access in the urban context
- Preliminary side aperture sizing
- Side aperture design
- DF calculation

Assignment: Calculate the DF for a classroom located in the building analyzed in assignment C5.

03.06 **7. <u>The DF calculation - shading</u>**

- Overheated period
- Façade design tool
- Overhang, fin an eggcrate shading options
- Shade mapping onto sunmask
- Impact of shading on sidelight DF
- Shading effectiveness using Climate Consultant

Assignment: Determine appropriate shading for classroom and its impact on DF.

03.13 **8. <u>The DF calculation – adding a skylight and countering glare</u>**

- Sizing a skylight addition
- Locating the aperture

- The role of the skylight throat
- Aperture glare and glare reduction strategies

Assignment: add a skylight to the classroom and develop glare reduction strategies.

03.20 **9. Break**

03.27 **10. The daylighting / electric lighting interface**

- Luminous efficacy
- Lamp type and color temperature
- Lamp color rendering
- Fixture reflector and enclosure
- Calczone illuminance calculation
- Lighting controls

Assignment: develop an electric lighting and control solution to the classroom

04.03 **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.

04.10 **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.

04.17 **14. Advanced Daylighting Systems**

- Glazings
- Light shelves
- Light guides

Assignment: daylight model. See above.

04.24 15. **Daylight model review**

05.01 16. **No class**

05.08 16. **Final review**

Assignment: presentation of final daylight model