Course Syllabus

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

Time: Thursday, 1100h-1300h

Room: Avery 505

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 of light and space. Then we will shift to the primary relationship of the sun to the building over time. Then investigate the basic means by which daylight interacts with and visually articulates architectural space. Then we will focus on architectural means to modulate and control daylight – shading, wall thickness, light traps, glass layering. We will then move on to various perimeter (ex: external reflectors) and core strategies (ex: light pipes) that can provide additional daylight to the interior and drive it deeper. We will then discuss various advanced daylighting systems and technologies (ex: heliostats).

Daylighting analysis methods: conventional and advanced simulations of quantitative conditions

For conventional daylighting analysis we will use the Daylight Factor Method. For advanced daylighting analysis we will use Rhino Diva. Based on Radiance code first developed at Lawrence Berkeley National Labs, now reinterpreted by the Daylighting Lab at MIT, it is the most sophisticated daylighting analysis tool presently available. With Rhino for modeling, Diva is easy to use and delivers both accurate quantitative daylighting analysis but also physics based light renderings. We will use a simple NYC classroom model to develop RD skills and to learn how to interpret and apply RD results to design.

Final daylighting project:

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.

Daylighting analysis methods: modeling of qualitative conditions

For the final project students will use a more traditional but none the less informative analytical tool: the architectural daylighting model. Because light, as a matter of physics, behaves similarly at

all scales but the subatomic, the daylighting model studied outdoors in the sun and under the clouds is critical to our understanding of some of the broad and more subtle interactions of space and light.

Resources/Assignments/Grading

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 account for 60% of the final grade. There are no tests or exams but the daylighting model will be a key measure of semester performance and account for 40% of the grade. All assignments are weekly and are submitted to Coursework in 11x17xpdf format. I will review and grade them then post grade and notes to Courseworks by the next class.

Schedule:

01.19   **1. <u>Daylight Masterworks</u>**

- Course introduction and description
- Case studies: an historical review of important daylighted structures from the hypostyle hall at Karnak to LeCorbusier's Ronchamps.

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

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

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

Assignment: case study. See above

02.02   **3. <u>Daylight Access</u>**

- Sunmask: introduction to solar pathways for the day, month and year
- Sunshots: using Google Earth to create a site solar access profile.
- Sunsurveyor: using a cellphone app to map sunpath on camera view(s)
- Climate consultant: Determining and applying clear vs cloudy sky conditions over time.

Assignment: Develop a solar access profile for the courtyard between Avery and Buell Hall.

02.09   **4. <u>Daylight in the Atmosphere</u>**

- Daylight interactions with materials: reflection, refraction, transmission
- Daylight metrics (luminous flux, illuminance and luminance); light quantification
- Daylight and interactions with air, water, ice, dust, magnetic fields in the atmosphere.

Assignment: Design a singular space that explains and exploits a singular atmospheric phenomenon.

02.16   **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 mask to determine the Daylight Factor on the exterior of a NYC classroom in a midrise and shaded NYC tower.

02.23 **6. The DF calculation - sidelighting**

- Required illuminance
- Solar access in the urban context
- Preliminary side aperture sizing
- Side aperture design
- DF calculation using the sunmask and pepperpot diagram.

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

03.02 **7. Daylight in the Eye – photo-optical mechanics and its limits**

- Eye and optics: lens and its focal length.
- Eye and vision: night (rod) vs day (cone) vision and impact on color.
- Glare as visual liability and architectural potential

Assignment: Design an aperture where the bone structure of the face and the limits imposed by it on what the eye can see creates an apparent void that, as an architectural fact, does not exist.

03.09 **8. The DF calculation – glass selection and shading**

- When to shade or reduce solar gains - the overheated period
- Glazing selection using the Facade Design Tool.
- Shading energy impacts using the Façade Design Tool
- Overhang design using Climate Consultant
- Fin design using Climate Consultant.
- Shading and architectural integration

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

03.16 **Spring Break**

03.23 **9. Rhino Diva I – introduction to daylighting analysis**

- Developing the Rhino model and daylight layering
- Importing the Diva climate data file
- Assigning materials to the Rhino layers
- Selecting and locating a viewpoint
- Running preliminary RD illuminance and luminance maps
- Judging the results

Assignment: Develop and import classroom model, assign materials and run Diva illum and lum simulations.

03.30   **10. <u>Rhino Diva II – key daylighting metrics</u>**

- Introduction of Spatial Daylight Autonomy and Annual Solar Exposure metrics
- Grid analysis with RD
- How to set up and run RD sDA and ASE simulations
- Output explanation and review
- Testing and confirming results.

Assignment: Using classroom model developed in A8, run grid based RD simulations

04.06   **11. <u>Rhino Diva III – electric lighting and daylighting dimming controls</u>**

- Electric light and energy use
- Light fixture and lamp selection for energy efficiency and color rendering
- Different space = different electric lighting strategy
- Electric lighting and glare
- Daylighting dimming and electric lighting – options
- Daylighting dimming – RD evaluation of energy impact.

Assignment: Develop an electric lighting scheme for the classroom and use RD to test it for daylight dimming.

04.13   **12. <u>Sky and Atrium Lighting</u>**

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

Assignment: narrative and drawings that describe daylight model

04.20   **13. <u>In class presentation of daylight model projects</u>**

04.27   **<u>No class</u>**

05.01   **14. <u>Daylight model review (preliminary)</u>**

- Individual with DN

05.05   **15. <u>Daylight model review (final)</u>**

- Individual with DN