COLUMBIA UNIVERSITTY

School of Architecture, Planning and Preservation

SUSTAINABLE DESIGN (GSAPP) – FALL 2017

Course number: ARCH A4684_001

Time: Friday, 11:00 – 13:00

Room (verify): Avery A408

Instructor: Davidson Norris - Davidson Norris Architect & Carpenter Norris Consulting

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NOTE:

This course is offered for students who are interested in the DESIGN implications of Sustainable Design. If you are more interested in the broader non-design implications of sustainability, consider taking A4684_002: Sustainable Design (Earth Institute).

Description:

Sustainable Design recognizes that the architect's primary challenge is the poetic integration and inspired balancing of multiple technical, and sometimes conflicting, sustainable options. To address this, the course introduces the student to the core technical principles that govern sustainable design and, in parallel, requires their inspired and poetic application to the design of a New York City High School.

In a series of weekly lectures the instructor will present core principles and practices of sustainable design. See below for specifics. Lecture slides will be posted before each class on Courseworks. A bibliography of back-up readings will also be posted, with many selections available on reserve in the Library.

There are no exams or papers. To begin, homework assignments will focus on a case study followed by a semester long sketch design problem. The design problem will require the successive application of sustainable techniques and technologies, described in the weekly lectures, to the design of a very simple site and building – a classroom block with 9 classrooms for a High School for Environmental Science (HSES). Acting as your sustainable design guide and consultant, the instructor will review and comment on the student's developing design. The final integrated sustainable design will be presented for review at the end of the semester.

While the program for the HSES will be identical, the student will have the option of developing it in one of 4 different climate types (cool, temperate, hot/wet or hot/dry). In all climate cases the site and context (urban) will be the same – Central Park in New York City.

Class Assignments & Final Project:

1. Development and presentation of case study highlighting sustainable design.
2. Weekly sketch design application of that week's sustainable strategy to your HSES design. See assignments below for each class.
3. Final project: HSES presentation.

Textbooks:

While there are no required texts books for the course I highly recommend that you purchase Sun, Wind & Light, Architectural Design Strategies, latest edition, Brown, G. and DeKay, M., Wiley. Written by architects for architects, it outlines sustainable strategies, techniques and technologies, provides helpful sizing graphs and charts, and offers many excellent examples of their architectural application. It is the basis for much of my instruction and should be a foundation document in your sustainable design library going forward.

Software:

Over the course of the semester, we will rely on a number of softwares. All are downloadable from the internet.:

PMV Tool – CBE Thermal Comfort Tool for ASHRAE-55 (http://comfort.cbe.berkeley.edu)

Climate Consultant (http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php)

Façade Design Tool (http://www.commercialwindows.org/fdt.php (Links to an external site.)Links to an external site.)
Energy analysis - SEFAIRA (http://sefaira.com (Links to an external site.)Links to an external site.)

Sefaira is not public domain but is available free of charge for our class. You will be given a temporary license. To use Seafira your model will have to be developed in Sketchup, also available free to students. Sefaira allows you to test preliminary sustainable design strategies using a simple SketchUp model with the Sefaira plug-in on your own computer. Once settled on your home screen you can then export the model to Sefaira's servers for more fine-grained parametric analysis.

Class Schedule

09.08 1. The sustainable building argument

- Energy, economic, productivity and architectural rationales
- Case study: the Bullitt Center, Seattle
- Assignment: case study

09.15 2. Sustainable building fundamentals

- Personal thermal comfort and psychrometrics
- Sun/earth relationship
- Microclimatic variables
- Integrated sustainable design

Assignment: productivity optimization exercise using psychrometrics

09.22 3. Sustainable building psychrometrics and internal gains

- Building psychrometrics
- Climate zones
- Introduction to Climate Consultant (CC)
- Internal gains: sources and energy impacts

Assignment: HSES climate analysis using Climate Consultant

09.29 4. Sustainable site strategies

- Building psychrometrics
- Sun mask and obstruction mapping
- Solar orientation and spacing
- Daylight access
- Wind mapping using CC5 and management

Assignment: HSES site analysis and selection

10.06 5. Sustainable waste and water management

- Water conservation targets and solutions
- Waterless waste solutions
- Greywater and blackwater management
- Site and building storm water collection and management
- On site waste treatment

Assignment: HSES waste and water plan

10.13 6. Sustainable Building Design – envelope strategies

- Building orientation as response to sun and wind
- Building aspect ratio as response to local climate
- Sustainable programming and space distribution
- Envelope heat loss and gains
- Envelope insulation
- Envelope glazing and window to wall ratio
- Envelope infiltration prevention
- Building scale energy impacts of envelope strategies

Assignment: HSES schematic design and siting

10.20 7. Sustainable Building Design - active and passive solar heating

- Active solar water and space heating
- Passive direct gain
- Passive trombe wall
- Passive sunspace

Assignment: Apply passive and/or active solar heating to HSES

10.27 8. Sustainable Building Design – passive cooling

- Ground contact cooling (mass)
- Ground contact cooling (air)
- Skytherm
- Night flush ventilation
- Overheated period and shading options

Assignment: Apply passive cooling to HSES

11.03 9. Sustainable Building Design – Natural ventilation

- Wind driven ventilation
- Wind ventilation and building form and orientation
- Wind ventilation and window placement and area
- Wind towers
- Stack effect driven ventilation
- Hybrid wind and stack effect systems

Assignment: Apply natural ventilation to HSES

11.10 10. Sustainable Building Design - daylight

- Lighting power density comparison of daylight and electric light
- Daylight spectrum, reflection and transmission
- Daylighting sky types and illuminance
- Daylight factor and perimeter daylighting
- Core daylighting with atria
- Daylight, visual comfort and glare
- Advanced daylighting analysis using Sefaira

Assignment: Apply daylighting to HSES

11.17 11. Sustainable Building Design - Indoor environment

- Site issues
- Ventilation
- Material Selection
- Maintenance

Assignment: HSES design integration and development of Sefaira model

11.24 THANKSGIVING - no class

12.01 12. Sustainable Building Design – mechanical systems

- District heating
- On site electric generation
- Advanced boilers
- Alternate fuels – wood chips
- Heat pumps
- Gas fired chillers
- Ice cooling
- Heat recovery
- Chilled beam heating and cooling
- 6 surface radiant heating and cooling

Assignment: HSES design integration and development of Sefaira model